NATURAL RESOURCES AND THE ENVIRONMENT

THE LEELANAU GENERAL PLAN

Policy Guidelines for Managing Growth on the Leelanau Peninsula

Working Paper Number 9

August 6, 1992

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Working Paper #9
NATURAL RESOURCES AND THE ENVIRONMENT OF THE LEELANAU PENINSULA

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PREFACE

This working paper is the ninth in a series providing background information for the preparation of the **Leelanau General Plan: Policy Guidelines for Managing Growth on the Leelanau Peninsula**. The first four papers were generated to document public input from county-wide growth management forums, the results of citizen and local officials surveys and the activities of the Citizens Advisory Committee (CAC). This committee studied the need for a new county plan and various approaches that could be taken in the preparation of such a plan. They concluded that while a new plan was needed, it should not be simply another *"County Comprehensive Plan"* prepared by the County Planning Commission. Instead, what is needed is a growth management plan for the Peninsula that involves the direct input and participation of all the local units of government in the County. This led to the initiation of the **Leelanau General Plan**. The fifth working paper presented a report on the "Trend Future" facing Leelanau County. Working paper #6 presents goals and objectives for the **General Plan**, working paper #7 provides an overview of the economy of Leelanau County, and working paper #8 discusses transportation, public facilities, and physical services.

This working paper (#9) addresses Leelanau County's environment and natural resources through the following chapters:

Chapter 1 - **Climate, Geology, Topography, and Drainage**; this chapter identifies and discusses the most fundamental, formative natural processes affecting the County's natural setting and resources.

Chapter 2 - **Natural Resources**; discusses nature and location of soil types, farmlands, forest lands, woodlands, sand and gravel resources. For soils, there is information pertaining to building site development and limitations for septic systems and basements.

Chapter 3 - **Environmentally Sensitive Areas**; Floodplains, wetlands, high risk erosion areas, shorelands, sand dunes, and unique natural features are the topics addressed in this chapter. Environmentally sensitive areas present both problems and opportunities for development in the Peninsula. Implications of ill-considered development, special characteristics of sensitive areas, and state legislation are discussed for these parts of the County.

Chapter 4 - **Air and Water Quality**; provides information on these abundant yet fragile resources. Subjects addressed are sources, measured impacts, and future status of air and water quality in Leelanau County. The chapter discusses regional and local sources and impacts of pollution.

Chapter 5 - **Summary**; reviews the issues raised from the first four chapters and identifies problems and opportunities for Leelanau County. The chapter also relates the significance of the information presented in the working paper to future development activity in the County.

EXECUTIVE SUMMARY

The purpose of this working paper is to provide an information base that can be used for addressing environmental issues and concerns in Leelanau County. The following chapters should provide local officials and citizens with information needed to make sound decisions with respect to the natural environment. Information is presented in a fashion which will promote understanding of the environment; both at this time and in the future.

This working paper provides information on; surface and bedrock geology, temperature and precipitation, watercourses, water quality, shoreline erosion, air quality, resource lands, pollution sources, and environmental problem areas. Geologic formations, resource lands, environmentally sensitive areas, and pollution sources are identified and mapped.

The following are summary observations from the working paper:

- Leelanau County has a diverse and varied surficial geology resulting from glaciation. Glacial landforms present in the county include moraines, drumlins, eskers, outwash plains, kettles, and sand dunes. Glacial deposits are very thick in portions of the county.
- The County's climate is influenced by the water bodies surrounding it. This makes some portions of the Peninsula suitable for growing fruit trees.
- Leelanau County has no major watercourses subject to flooding or severe erosion, but has many small creeks and streams.
- Great Lakes water levels have varied as much as 5¼ feet within a 30 year period from the early 1960's to the present. The effect of lake levels is magnified by wind and wave action.
- Significant portions of the Peninsula have soils which pose severe limitations on development because of erosion potential, steep slopes, high water table, or excessively fast or slow permeability.
- Large contiguous areas of the County have unique suitability for orchards, woodlands, or farmland. Prime forestland soils cover approximately 70% of the Peninsula.
- Although a small portion of the Peninsula contains wetlands, they exist in two very large contiguous areas near Lake Leelanau and are a significant factor in maintaining the water quality of that lake.
- The Great Lakes shoreline in Leelanau County contains many areas with highly erodible shore types which could be adversely affected by unchecked development.
- Air and water quality in the County is affected by activities hundreds of miles away in the Lake Michigan basin.
- Water quality in inland lakes on the Peninsula is very good, but the water quality of some lakes is threatened by septic systems and agricultural runoff. Continued residential development introduces additional impacts, including stormwater runoff containing lawn and garden chemicals as well as other household chemicals (cleaners, detergents, etc.), and increased soil erosion resulting in sedimentation. Creeks and streams in the County are generally high quality, but some problem areas exist.
- The high water quality of North Lake Leelanau is threatened by elevated levels of nutrients entering the lake from Houdek Creek. Much of the Houdek Creek watershed area contains agricultural land uses. Sources of the problem are agricultural runoff, cherry cooling pads, soil erosion, road crossings, and residential septic systems. Recent data for other streams in the County do not

indicate the existence of such problems elsewhere.

- All residents and visitors of the Peninsula are dependent on groundwater for potable water. This resource is threatened by agricultural practices, failing septic systems, and point sources of chemical contamination.
- Groundwater (and thus surface waters) in Leelanau County is extremely vulnerable to contamination due to a thick layer of highly permeable soils and the presence of many unconfined glacial drift aquifers.

Many of the emerging issues identified within this report are natural resource-based, interrelated with recreation planning, land use planning, regulation of land use, and economic development. The natural resources of Leelanau County offer a bounty of recreational opportunities which can be of benefit to the local economy. If development for recreation or other uses is ill-conceived or insensitive to the environment, the quality of recreation and the local economy will suffer. The chances of this happening are greater with increased pressure for development experienced over the past ten years. Land use planning and regulation will be increasingly necessary to ensure sustainable use of the Peninsula's natural resources.

From the information presented in this working paper, it is evident that the natural environment of the Leelanau Peninsula is composed of many unique and fragile resources that are easily impacted by man's activities. Several warning signs have been observed and documented within the past twenty years that prove this is true. If protected by adequate governmental policies and regulations with the support of informed citizens, the Peninsula's environment can be preserved for enjoyment by many people far into the future.

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Chapter 1

CLIMATE, GEOLOGY, TOPOGRAPHY, AND DRAINAGE

INTRODUCTION

Climate, geology, topography, and drainage are key factors in shaping the natural environment of Leelanau County. This chapter provides background information on past and existing conditions related to these important fundamental elements of the environment. The purpose is to serve as a foundation for further discussion natural resources, environmentally sensitive areas, water quality, and land use planning.

Leelanau County is a unique place in Michigan with respect to climate and topography. The climate is influenced by the large water bodies surrounding the Peninsula, which have a moderating effect on temperatures. The surface geology of Leelanau County features large moraines, drumlins, sand dunes, eskers, outwash plains, and a thick layer of glacial drift. Topography in the County is unique because of distinct glacial and sand dune features, with many areas having steep slopes and rolling hills. Drainage is facilitated by steep slopes, numerous small creeks and streams, large inland lakes, and sandy soils.

CLIMATE

Effects of Surrounding Water Bodies[1]

Leelanau County, surrounded on three sides by fresh water, has a climate that is Midwest continental but is influenced during critical parts of the growing season by the heat-exchanging properties of Lake Michigan. Prevailing winds are west-southwest off Lake Michigan. The lake effect provides a favorable environment for fruit trees, as the lower temperatures during spring generally retard the blooming time until the danger of late killing frost has generally passed. Weather records taken from observations at Glen Arbor and Maple City show that weather in Leelanau County is somewhat milder in winter and somewhat cooler in summer than weather at Traverse City. This is due to the effect of surrounding water bodies.

Average Temperatures and Precipitation

Table 1-1 on the following page shows climatic data for Traverse City that is generally representative for Leelanau County. The Peninsula's weather is only slightly different than that of Traverse City as a result of the lake effect. The highest daily temperatures occur in July, while the lowest daily temperatures occur in February. Precipitation is highest during May and lowest during February.

Growing Season[1]

Fruit growers are primarily concerned about the average frequency and severity of frost damage to fruit trees and the probability of damaging frost during blossom time. In Leelanau County, local variations in the frost hazard to fruit growing range from slight to severe, depending to a large extent on elevation above the lowlands and on effective natural air drainage. The length of the growing season is about 150 days. It is somewhat shorter in the south-central part of the Peninsula, and longer on the offshore islands. The average date of the last freezing temperature in the spring in Traverse City is May 10, and the average date of the first freezing temperature in the fall is October 7. The latest freezing temperature ever recorded in Traverse City is June 13, and the earliest on record is September 12.

GEOLOGY

Bedrock Geology

Leelanau County is located above four major bedrock formations; the Detroit River Group, the Traverse Group, Antrim Shale,

and Ellsworth Shale. Figure 1-1 shows the location of each major bedrock group within the County. The shale and sandstone bedrock is overlaid by 50 to 900 feet of glacial drift surface material, which is thickest near the Sleeping Bear Dunes and becomes thinner towards Suttons Bay and Northport. There are no outcroppings of bedrock in the Country.

Physiography and Surface Geology[1]

The surface of the Peninsula is covered by ground-up rock material resulting from the Wisconsin period of glaciation 10,000 to 20,000 years ago. This material ranges from clay or loams to sand and gravel and contains boulders, stones, and limestone slabs. All of this earth mass was moved by ice from the north during several glaciation periods.

Erosion by wind and water has modified the surface configuration, mainly by moving soil material from higher to lower elevations, sculpturing the hills, and cutting drainageways. Strong winds built the high dunes along Lake Michigan and moved surface soil material from one place to another. Sand dunes occupy most areas adjacent to Lake Michigan on the mainland and on the islands. The Sleeping Bear Dune reaches an elevation of 1,044 feet and is the most pronounced of the open dune land.

Winds and water cause severe natural geologic erosion on dune-land. Wave action during periods when lake levels are high causes shore erosion, and by undercutting lake bluffs, induces slippage of large soil masses. Large active gullies, some well over 100 feet, occur where natural drainage-ways receive accelerated runoff from cultivated fields and spill over steep escarpments.

The most distinct inland feature resulting from glaciation is the hilly morainic landscape in the southern two-thirds of the Peninsula. The Manistee Moraine occupies the central part of the County between Empire and Suttons Bay. Loamy sand is more dominant in the eastern part of this moraine, but toward the west there is a change to a higher proportion of gravely material, and in the western part there is sand. The moraines in

Table 1-1
CLIMATIC INFORMATION

Month	Temperature		Precipitation		
	Average daily maximum (° F)	Average daily minimum (° F)	Average total (inches)	Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover (inches)
January	30	17	1.9	30	8
February	30	15	1.3	28	10
March	38	21	1.6	22	8
April	52	32	2.0	3	2
May	65	41	3.0	0	0
June	76	53	2.6	0	0
July	82	59	2.6	0	0
August	79	58	2.6	0	0
September	71	51	3.7	0	0
October	59	41	2.9	0	0
November	44	30	3.0	9	4
December	33	22	1.7	24	5
Year	55	37	29.1	116	6

Source: USDA Soil Survey of Leelanau County, Michigan

the northern part of the Peninsula and west of Lake Leelanau contain a high proportion of sandy loam. Also in the northern part of the County are numerous unusual elongated hills known as drumlins.

Lake levels varied greatly from time to time, and as water levels dropped, former-lake bottoms were exposed as lake benches and lake terraces. These lake benches and terraces occupy areas adjacent to the larger lakes and along the shores of Lake Michigan and Grand Traverse Bay. These are nearly level to sharply sloping, and the soil material of the lake deposits is stratified sand, gravel, loams, silts, and clays.

Glacial outwash plains occupy a large area in the southwestern part of the Peninsula. They are nearly level to gently sloping, but have a number of deep pits, and are deeply dissected in some places, especially near their borders. The soil material is mostly either gravel or sand.

Each of the offshore islands differ greatly from one another in surface geology. South Manitou Island consists of crescent-shaped glacial deposits. These begin on the east side as nearly level lake benches. To the west, and in higher elevations, are level glacial lake plains, which rise sharply to a steep clayey moraine that is crowned by dune sand next to Lake Michigan. North Manitou Island has a narrow shelf of lake benches that rises abruptly to a broad moraine. This broad moraine is split in the middle by an outwash plain that extends southward to the dunes that occupy the southern and western areas along Lake Michigan.

Nearly all of South Fox Island is one big dune reposing on a moraine and on an old lake plain, both of which are exposed only on some narrow shelves. North Fox Island is two-thirds lake plain swept clean of superficial lake deposits down to the sandy loam glacial till. The southern one-fifth is a high dune deposited on the moraine, and the rest is lake benches.

TOPOGRAPHY AND SLOPES

Relative Elevations

The highest point in Leelanau County, slightly over 1,100 feet above sea level, is part of a large moraine located in the southwest corner of Elmwood Township. The next highest point is the Sleeping Bear Dune, at 1,044 feet above sea level. Sugarloaf Mountain is another prominent high point, at 1,040 feet.

From the mean water level of Lake Michigan, which is 580 feet, three of the more prominent pinnacles of Sleeping Bear Dune, Fouch Hill, and Sugarloaf Mountain rise about 460 feet. The large outwash plain in Kasson township is about 340 feet above Lake Michigan, and the moraines in the central part of the Peninsula rise approximately 200 to 400 feet above Lake Michigan.[1]

Some relatively large expanses of flat terrain are found in the Solon and Cedar Swamps south of Lake Leelanau, much of the southern portions of Empire and Kasson Townships, and much of Leelanau Township north of Northport. All of the offshore islands have relatively flat terrain as well (see Figure 1-2).

Steep Slopes

Approximately one third of the land area of Leelanau County has slopes of 12% or greater (See Figure 1-3). These steep-sloped areas are not concentrated in one location but are found throughout the county, and are generally interspersed with flat and moderately sloped land. Virtually the entire Peninsula is hilly, except for the extreme south-central portion in southern Empire and Kasson Townships, and the swamps south of Lake Leelanau.

Steep slopes place moderate to severe limitations on development, especially in highly erodible soils such as those in Leelanau County. Generally, slopes exceeding 7% should not be developed intensively, while areas having a slope of 15% or greater should not be developed at all because of increased soil erosion and surface water sedi-

mentation. Careless hillside development can lead to increased costs for public services such as road and sewers, and results in damage to surface water quality.

The permeable unconsolidated glacial deposits in Leelanau County permit percolation of absorbed water to a great depth. This water moves laterally through the ground until it appears again as springs or as underwater discharge into streams and lakes. Many of the valleys and drainageways are dry during much of the year, but swamps remain wet in low areas having a high groundwater level. Rapid runoff of water is slight and occurs mostly during periods of rapid snowmelt, particularly if the surface soil is frozen. Runoff from cultivated sloping fields is rapid if they are not protected by appropriate measures to conserve soil and water.[2]

WATERCOURSES AND WATERSHEDS

Watersheds and Drainage Patterns

There are no major rivers or river systems in Leelanau County. Much of the land in the Peninsula drains directly into either Lake Michigan or the west arm of Grand Traverse Bay via small creeks. Two large inland lakes, Glen Lake and Lake Leelanau, drain the central portions of the Peninsula, but eventually empty themselves into Lake Michigan.

The Lake Leelanau watershed (drainage area) covers approximately one fourth of the Peninsula and extends southward into Benzie County. There are two other inland watersheds which drain the central part of the County. One is an area containing Lime, Shetland, and Shalda Creeks, as well as Bass, Lime, School, Shell, and Little Traverse Lakes, and occupying most of Cleveland Township. The other contains Hatlem Creek, Glen Lake, and the Crystal River. Figure 1-4 shows watersheds and watercourses in Leelanau County.

Watercourses

All of the rivers or streams in Leelanau County are short-run creeks which drain directly into the Great Lakes, connect inland lakes, or run from inland lakes into Lake Michigan or Grand Traverse Bay. Table 1-2 contains location and drainage information on these watercourses.

Inland Lakes

Inland lakes cover approximately 8% of Leelanau County. The largest of these lakes are Lake Leelanau and Glen Lake. Table 1-3 contains information on eight of the largest lakes in the county

LAKE LEVELS

Lake Michigan

Lake levels on Lakes Michigan and Huron have varied considerably; as much as 5¼ feet; over the past thirty years, with record low's recorded in 1964 and record high levels in 1986. Figure 1-5 shows Lake Michigan/Huron levels in 1964 and 1986, as well as the long-range trend and levels for the years 1991 and 1992.

Great Lakes water levels are unpredictable and vary over time in relation to precipitation and evaporation, and to a lesser extent, winds. Water levels are also affected by such artificial factors as dredging, diversions, and regulation of flows. Following long periods of above average annual precipitation, there is an accompanying rise in water levels. This rise is not immediately evident because there is a delay between the time precipitation falls within the Great Lakes drainage basin and the time all runoff waters finally enter the lakes. The same relationship also holds true for periods of low precipitation; lower lake levels are not immediately evident.[3]

In addition to precipitation and evaporation, strong winds can actually tilt the surface of some of the Great Lakes, by pushing the water to one end, by as much as eight feet on the receiving end. The other end of the lake is consequently lowered. This effect of strong winds is common along the eastern shore of Lake Michigan in areas such as Leelanau County.

Table 1-2
WATERCOURSES IN LEELANAU COUNTY

Name of Watercourse	Location	Drainage
Beaudwin Creek	Leland Township	Lake Leelanau
Belangers Creek	S. Leelanau and Suttons Bay Twps.	From Bass Lake to Suttons Bay
Belnap Creek	Elmwood Township	Lake Leelanau
Bodus Creek	Centerville Township	To Victoria Creek to Lake Leelanau
Brewery Creek	Elmwood Township, Greilickville	Grand Traverse Bay
Cedar Creek	Elmwood Township	Cedar Lake
Cedar Run	Solon Township	Lake Leelanau
Clearbrook Creek	Solon Township	To Victoria Creek to Lake Leelanau
Crystal River	Glen Arbor Township	From Glen Lake to Lake Michigan
Ennis Creek	South Leelanau Township	Grand Traverse Bay
Gills Creek	South Leelanau Township	Lake Michigan
Hatlem Creek	Empire Township	Glen Lake
Hines Creek	Elmwood Township	Cedar Lake
Houdek Creek	South Leelanau, Leland Townships	Lake Leelanau
Lee Creek	Bingham Township	Grand Traverse Bay
Leland River	Leland	Lake Leelanau to Lake Michigan
Leo Creek	Suttons Bay	Suttons Bay
Lime Creek	Cleveland Township	Lime Lake
Mebert Creek	Bingham Township	Lake Leelanau
Northport Creek	Northport	Northport Bay
Rice Creek	Centerville Township	Grand Traverse Bay
Shalda Creek	Cleveland Township	L. Traverse Lake to Lake Michigan
Shetland Creek	Cleveland Township	Lime Lake to Little Traverse Lake
Tager Creek	Solon Township	Cedar Run to Lake Leelanau
Victoria Creek	Centerville, Solon Townships	Lake Leelanau
Weaver Creek	South Leelanau Township	Omena Bay
Weisler Creek	Solon Township	Lake Leelanau

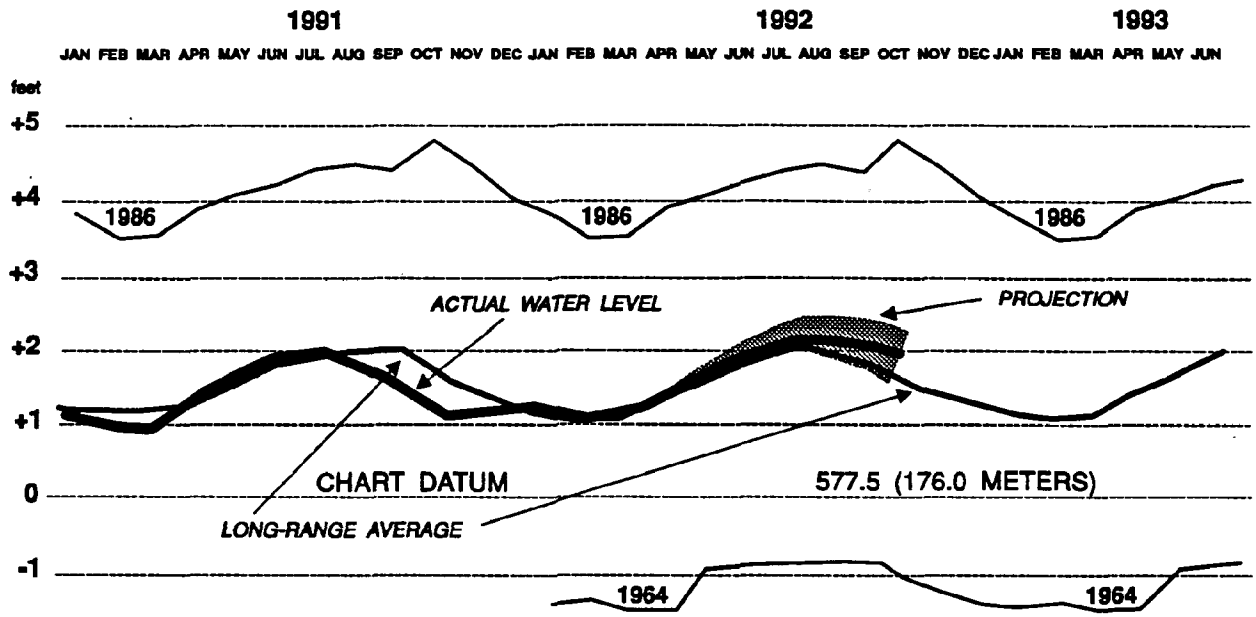
Source: Various maps of Leelanau County

Table 1-3
INLAND LAKES - 175 ACRES OR LARGER

Name of Lake	Surface Area (acres)	Maximum Depth (feet)
Lake Leelanau (North)	2,950	121
Lake Leelanau (South)	5,370	62
Glen Lake (Little)	1,400	13
Glen Lake	4,865	130
Little Traverse Lake	640	54
Lime Lake	670	67
Cedar Lake	253	45
School Lake	175	18

Source: Michigan Department of Natural Resources

Figure 1-5
GREAT LAKES WATER LEVELS



Source: U.S. Army Corps of Engineers

During periods of high water levels on the Great Lakes, damage to shorelands is much greater than in years of average or low water. High water levels, combined with the forces of strong wind and wave action, can destroy beach and bluff areas, force evacuations of flood-prone areas, and damage bird nesting and fish spawning grounds.

Many areas along the eastern shore of Lake Michigan are highly susceptible to erosion, especially when lake levels are high. In 1972 and 1973, flooding along the eastern shore of the Lake in Michigan affected 10,000 homes and cost 55 million dollars in damages. A storm that occurred on December 1-2, 1985, described by the National Weather Service as a "typical fall storm" caused an estimated $12-$14 million in damages to the six southern Michigan counties on Lake Michigan, mostly due to high water levels. The storm destroyed 16 cottages, damaged 46 others, and placed another 108 in imminent danger.[4]

Inland Lake Levels

There are two lakes in Leelanau County which have legally established water levels. Lake Leelanau's legally set level of 589.21 feet mean sea level datum was established in October, 1978. The level, with a variance of plus zero inches, minus two inches, is in effect from April 15 (or when the ice breaks up, whichever is later) until November 15. As of November 15, the water level is to be reduced to 585.21 feet until the following April 15.

Glen Lake's level was ordered to be 596.75 feet mean sea level datum at the south pier of "the Narrows" bridge in Section 3 of Empire Township as of July, 1945. The level is maintained by the Glen Lake Association.

EMERGING ISSUES

Development on steep slopes

As areas most suitable for development are built upon (those areas with good soils

for construction and septic systems and with slight or moderate slope), then building on more marginal land is likely to occur. In Leelanau County, such "marginal" areas for building have steep slopes and highly erodible soils. If these areas are not protected from haphazard development, several important elements of the Peninsula's natural environment are at risk, including scenic beauty, high lake water quality, fragile dune lands, and unique vegetation.

Impacts of High Lake Levels

Shoreline development along Grand Traverse Bay and Lake Michigan should occur with potential high water levels taken into consideration. Property damage resulting from inundation and erosion also affects the local economy because of its dependence on tourists and tourist related facilities. Any substantial damage to such facilities could have long-lasting negative effects. It is possible and feasible for future development to be protected from high Great Lakes water levels by setting minimum standards for the distance of structures from the water's edge.

ISSUES FOR FURTHER DISCUSSION

To what extent should local governments or the County take over responsibility for development in high risk erosion areas? Currently, the Michigan Department of Natural Resources administers permit programs designed to protect these sensitive areas.

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1. Substantial portions excerpted from the **USDA Soil Survey of Leelanau County**, Michigan.
2. **USDA Soil Survey of Leelanau County**, Michigan. 1973.
3. **Great Lakes Water Levels**, Michigan Department of Natural Resources, Division of Land Resource Programs. Date unknown.
4. **Great Lakes Water Wreaks Shore Havoc, Natural Resources Register**, Michigan Department of Natural Resources. March, 1986.

Chapter 2

NATURAL RESOURCES

INTRODUCTION

Soils-based natural resources discussed in this chapter include farmlands, forest lands, sand and gravel. Leelanau County is relatively plentiful with respect to all of these natural resources, which lend substantially to its scenic beauty and are crucial to its economic base.

Approximately one third to one half of the Peninsula is not suitable for urban type development because of various soil related limitations. Many areas of the County have soils which are on steep slopes, have excessive wetness, or are excessively permeable. However, many of the areas which are unsuitable for development have unique suitability as orchards, farmland, or prime forest land. Land use policies should focus on guiding new development into areas capable of supporting it, while discouraging development and possible inadvertent misuse of valuable resource lands.

SOILS

Soil Types and Locations

There are eight general soil associations present in Leelanau County. Each soil association has unique characteristics which pose opportunities for some uses and limitations for others. The soil associations consist of one or more major soil types and at least one minor type, and are named for the major soils. Figure 2-1 shows general soil associations in the county. This map is useful for locating large tracts of land which may be suitable for a particular type of use, or for managing wildlife, watersheds, recreational facilities, or forests. However it is not adequate for locating particular sites for roads, buildings, etc. Detailed site-specific analysis is needed for such purposes. Soil associations in Leelanau County are described in Table 2-1.

Table 2-1
SOILS ASSOCIATIONS

Soil Association	Characteristics	Minor Soils	Land Area
Deer Park-Dune Land	Well-drained, strongly sloping to very steep, sandy soils on dunes	Deer Park, Dune Land	13,402 acres 6% of county
East Lake-Eastport-Lupton	Well-drained and moderately well-drained, nearly level to gently sloping, sandy soils, and very poorly drained, nearly level, mucky soils; on lake terraces and beach ridges	Alpena, Au Gres, Edwards, Markey, Kalkaska, Roscommon	62,541 acres 28% of county
Emmet-Omena	Well-drained, nearly level to very steep, loamy soils on moraines	Alcona, Leelanau, Nester, Richter	26,803 acres 12% of county
Emmet-Leelanau	Well-drained, nearly level to very steep, loamy and sandy soils on moraines and till plains	Alcona, East Lake, Kalkaska, Mancelona, Richter	42,438 acres 19% of county
Kalkaska-East Lake	Well-drained, moderately steep to very steep, sandy soils on moraines	Mancelona, Wallace	17,869 acres 8% of county
Kalkaska-Mancelona	Well-drained, nearly level to strongly sloping, sandy soils on outwash plains	Adrian, East Lake, Houghton	24,570 acres 11% of county
Kiva-Mancelona	Well-drained, nearly level to strongly sloping, gravely, loamy and sandy soils on outwash plains	Kalkaska, East Lake	6,701 acres 3% of county
Leelanau-Mancelona	Well-drained, strongly sloping to very steep, sandy soils on moraines	East Lake, Kalkaska, Kiva, Nester	29,037 acres 13% of county

Source: USDA Soil Survey of Leelanau County, Michigan

Soil Limitations for Urban Development

The degree of soil limitations reflects the practical feasibility, expense, and environmental hazards of developing land for a particular use. Soils classified as severe have varying degrees of development potential based on the nature of their limitation. Slight, moderate, and severe limitations are interpreted as follows:

Slight: Relatively free of limitations or limitations are easily overcome.
Moderate: Limitations need to be considered, but can be overcome with good management or careful design.
Severe: Limitations are severe enough to make use questionable or impossible.

LIMITATIONS FOR BASEMENTS

Soil drainage, permeability, stability, frequency of flooding, slope, and erosion hazard are important considerations in determining the suitability of a site for buildings, especially those with basements. Soils having severe limitations for dwellings with basements are likely to have excessive wetness, slope, shrink-swell potential, or instability.

Figure 2-2 shows areas of Leelanau County having severe limitations for dwellings with basements. Approximately one third of the land in the Peninsula has moderate to severe limitations, primarily due to steep slopes, or wetness in low-lying areas. Areas with severe limitations are concentrated in extremely hilly portions of the Manistee Moraine and in the Cedar and Solon swamps south of Lake Leelanau.

LIMITATIONS FOR SEPTIC SYSTEMS

Soils can pose limitations on septic tank absorption fields for a wide variety of reasons, including excessive permeability, slow permeability, high water table, or combinations of rapid or slow permeability and high water table. Soils with severe limitations for septic systems can generally be broken down into the following categories.

A. Sandy, moderate to rapid permeability
B. Rapid permeability, wetness and high water table
C. Wet, ponding, heavier (clay) soils, slow permeability
D. Very wet soils, organics, floodplains, unable to support septic drainage fields

Soils in categories B, C, and D are not able to support septic fields because of extreme wetness. Soils in category A and B potentially allow unfiltered effluent to contaminate shallow groundwater supplies.

The Environmental Health Regulations for the Leelanau County Health Department specify minimum sub-surface areas for sewage disposal systems according to the size of dwelling and the type of soils naturally occurring at the site. These standards are shown in Table 2-2. The regulations also indicate that permits to install on-site sewage disposal systems will be denied for any of the following reasons:

A. Where any impervious layer of hard pan is encountered at less than four feet from the natural ground surface.
B. Where the known high groundwater table is encountered within four feet of the natural ground surface.
C. In heavy soils where the drop in water level is over 45 minutes per inch by standard percolation test.
D. Where silts, mucks, or unstable soils are encountered.
E. Where lot size does not provide adequate area to maintain the minimum requirements of the Environmental Health Regulations (i.e. there is insufficient land area to accommodate a septic system).
F. Where it has been determined that the proposed site of the sewage disposal system is subject to recurring flooding (50 year floodplain) or falls within a High Risk Erosion Area.

Table 2-2
SEPTIC SYSTEM STANDARDS

Soil	Minimum disposal area per single family residence		
	2 bedrooms or less	3 bedroom	4 bedroom
Coarse sand or gravel	450 ft²	600 ft²	750 ft²
Medium sand	600 ft²	750 ft²	900 ft²
Fine sand and loamy sand	750 ft²	900 ft²	1050 ft²
Sand loam	900 ft²	1050 ft²	1200 ft²
Loam and sand clay loam	1050 ft²	1200 ft²	1350 ft²
Clay, clay loam, and silt loam	not suitable	not suitable	not suitable

Source: Leelanau County Health Department, Environmental Health Regulations

NEW BENZIE COUNTY REGULATIONS

The Health Department in Benzie County, Leelanau's neighbor to the south, amended its health code in 1989 to include stringent requirements aimed at bringing older septic systems up to departmental standards. The program evolved out of concern over the potential for sewage contamination of groundwater and lakes, especially Crystal Lake.

Citizens were supportive of giving the Health Department greater authority to require individual upgrades where necessary. The Department expanded its authority by adding surface and ground water protection to the purpose statement of the new code and citing the Michigan Environmental Protection Act, MCL 691.1201 *et seq.*, for authority to minimize environmental degradation.

The new code requires inspection of septic systems by the Health Department prior to the sale or transfer of property and mandatory upgrades of substandard systems. It establishes two classes of property. Class I includes property with septic systems installed prior to 1972 or at any other time without Health Department approval. Class II includes those with septic systems approved and operating after 1971.

Class I properties are required to notify the Health Department of their status in writing. Once this notice is filed with the Department, Class I properties have the right to use the septic system for up to ten years thereafter at their own risk. Those Class I property owners which fail to file a notice will lose the ten year right and that system must be brought into conformance with Health Department standards within 120 days if it is not up to code.

Upon sale or transfer, *all* properties must be brought into compliance with departmental standards. Septic systems are inspected and wells are tested prior to sale. If the septic system is not up to code, the owner or purchaser must submit a proposed corrective action within 30 days of notice of non-compliance by the Department. If the proposed action is approved, it must be carried out within 120 days of approval. Before closing on the sale or transfer, the owner or purchaser must submit proof of conformance to the Department or a written contract that the sewage system will be brought into conformance. This contract must include a performance bond for one and one-half times the estimated cost of the improvement and a covenant that the performance called for will be completed within 90 days of sale.

USDA SOIL SURVEY

The USDA Soil Survey of Leelanau County rates soils according to their limitations for septic system absorption fields. This information is shown on Figure 2-3, which indicates that approximately one half to one third of the Peninsula has severe limitations for septic systems. These areas

are scattered throughout the County, but concentrations exist in and around the swamps southwest of Lake Leelanau and in Suttons Bay, southern Leelanau, and northern Leland Townships.

Health department sanitarians indicate that problem areas for septic systems are scattered throughout the County, but tend to be concentrated around lakes, particularly the east and southwest shores of North Lake Leelanau, and South Lake Leelanau. Areas with and approaching high nitrate concentrations in water wells are located in the vicinity of Cedar, Lake Leelanau, and Leland.

Large amounts of nitrate (greater than 10 ppm) in drinking water can cause serious illness in infants under six months of age. It may also cause illness in adults after prolonged use. In infants, the ability of the red blood cells to carry oxygen is reduced. A link between nitrate exposure and cancer has been suggested but not proven. Preliminary studies linking nitrates to cancer provide no hard evidence of such, however they do suggest a need for further studies.

HYDRIC SOILS

Hydric soils are another limitation on development. They are poorly drained, saturate easily, and retain large quantities of water. They are generally unsuitable for structures, roads, or sewage disposal systems. The USDA Soil Conservation Service defines hydric soils as:

> *"A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part".*[1]

If artificially drained, hydric soils can be suitable for farmland use. Figure 2-4 shows where hydric soils are located in Leelanau County. Most of these soils are found in wetland areas near inland lakes and in coastal marshes along Grand Traverse Bay and Lake Michigan. Relatively large concentrations of hydric soils are found in the swamps southwest of Lake Leelanau, along Leo Creek and Lee Creek south of Suttons Bay, along Mebert Creek and Lake Leelanau in Bingham Township, and in a line from Lake Leelanau to Cedar Lake to Grand Traverse Bay in Elmwood Township.

STEEP SLOPES

Erosion and accumulation of sediment are serious problems in construction of areas on sloping soils. As a result of vegetation removal, paving, and compaction of soils during and after construction, runoff from built-up areas is 2 to 10 times greater than from undeveloped land. This runoff travels at higher velocities than on undeveloped land and soil is consequently eroded. The eroded sediment is ultimately deposited into inland lakes and waterways. Figure 1-3 shows areas of Leelanau County having slopes of 12% or greater. Most parts of the Peninsula are highly vulnerable to erosion and sedimentation because of sandy soils.

SOILS MOST SUITABLE FOR URBAN TYPE DEVELOPMENT

Areas *most* suitable for urban types of development are shown on Figure 2-5. Inthese areas, soil limitations on dwellings with basements and on septic system absorption fields are considered to be only slight or moderate. Such soils, most of which are found in the western half of the Peninsula, comprise approximately 30% of the county's land area.

Soil Permeability

Leelanau County has many areas with highly permeable soils, mostly in the western half of the Peninsula, between the Lake Michigan shore and Lake Leelanau, and very few areas with slow permeability. These highly permeable soil areas serve to recharge groundwater in unconfined glacial drift aquifers. Some of these aquifers drain into inland lakes, which are vulnerable to contamination from the ground surface or from septic systems. Soil permeability is depicted in Figure 2-6.

Soils With Specific Suitability

WOODLAND SUITABILITY

All of Leelanau County's soil associations are suitable for either coniferous or hardwood trees. However, while some areas are well suited for hardwoods, they may be poorly suited for conifers, and vice versa. The suitability of soil associations for woodlands is summarized in Table 2-3.
Refer to Figure 2-1 for locations of soil associations.

Table 2-3
WOODLAND SUITABILITY

Soil Association	Conifer Suitability	Hardwood Suitability
Deer Park-Dune	excellent	poor
East Lake-Eastport-Lupton	excellent	poor
Emmet-Omena	poor	excellent
Emmet-Leelanau	fair	good
Kalkaska-East Lake	good	poor
Kalkaska-Mancelona	good	fair
Kiva-Mancelona	good	
Leelanau-Mancelona	poor	good

FARMLAND SUITABILITY

Most of Leelanau County is either poorly suited or not suited for grain and seed crops. Those areas which are most suitable for grain and seed crops are concentrated north of Suttons Bay and Lake Leelanau. Other somewhat suitable areas are scattered throughout the southeastern part of the Peninsula. Table 2-4 shows farmland suitability for the soil associations. Figure 2-7 shows farmland suitability more specifically by soil type.

ORCHARD SUITABILITY

The unique climate of Leelanau County, in conjunction with soils, makes some areas of the Peninsula ideal for orchards. There are many complex and interacting climatic and soil factors which make a particular site suitable for orchard use. Therefore the sites for orchards need to be carefully selected, even though soils may be suitable. Table 2-5 shows the suitability of soil associations for orchards. Figure 2-8 shows orchard suitability more specifically by soil type.

Table 2-4
SUITABILITY FOR SEED CROPS

Soil Association	Suitability
Deer Park-Dune	not suitable
East Lake-Eastport-Lupton	good
Emmet-Omena	fair
Emmet-Leelanau	good
Kalkaska-East Lake	not suitable
Kalkaska-Mancelona	poor
Kiva-Mancelona	fair
Leelanau-Mancelona	poor

Table 2-5
SUITABILITY FOR ORCHARDS

Soil Association	Suitability
Deer Park-Dune	not suitable
East Lake-Eastport-Lupton	good
Emmet-Omena	excellent
Emmet-Leelanau	good
Kalkaska-East Lake	poor
Kalkaska-Mancelona	poor
Kiva-Mancelona	fair
Leelanau-Mancelona	poor

FARMLANDS

Types and Location of Valuable Farmlands

There are three specific types of important farmlands in Leelanau County. These are prime farmlands, unique farmlands, and lands enrolled in the Michigan Farmland and Open Space Preservation Program authorized by PA 116 of 1974, MCL 554.702 *et seq.*

The USDA Soil Conservation Service defines prime farmlands as those best suited for food production; they require minimal soil enhancement measures such as irrigation and fertilizer to produce a sustained high yield of crops in an economical manner. There are 17,627 acres of prime farmland in Leelanau County, mostly in the eastern half of the Peninsula and concentrated in Cen-

terville, Leland, Suttons Bay, and Leelanau Townships (see Figure 2-9).

Unique farmland is land other than prime farmland that is used for the production of specific high value crops such as vegetables and tree, vine, and berry fruits. The soil qualities, landscape position, growing season, and moisture supply are those needed for a well-managed soil to produce sustained high yields of such crops in an economical manner. Leelanau County has 15,168 acres of unique farmland, mostly in the eastern half of the County (see Figure 2-9).

The Michigan Farmland and Open Space Preservation Program provides property tax incentives for landowners to preserve land for agricultural and open space use. The program allows landowners to enter into a voluntary agreement with the state whereby the land will remain in agricultural use for ten years. In return, landowners get a credit on their Michigan income tax, based on several factors including the local property taxes. Early withdrawal is penalized by required repayment of tax benefits, plus 6% interest. Landowners who do not renew the agreement must repay the past seven years of tax benefits. There are over 15,500 acres of land in Leelanau County enrolled in the program, scattered mostly throughout the eastern half of the Peninsula (see Figure 2-10).

FOREST LANDS

Types and Location of Prime Forest Lands

The Northwest Michigan Prime Forestlands Identification Project completed a prime forestlands report and map for Leelanau County in 1982 (see Figure 2-11). The report identifies three different types of prime forest land; prime timberlands, unique timberlands, and timberlands of regional importance. The identification of these lands is based primarily on soils; areas identified as "prime" may not actually be wooded but likely have the capability of supporting timber production. Prime forestlands in all of the three categories cover over 70% of the county.

Prime forestlands are those lands which are capable of producing sustained high yields of wood products. Capability is determined by the physical and chemical characteristics of the soil. Some of the physical and chemical characteristics of the soil that are taken into account are topography or terrain (slope, aspect, geologic landform), water availability (drainage, depth to water table, water holding capacity), soil depth and rockiness, fertility (texture, soil structure, mineralogy, banding), stability (stable enough to sustain intensive forest management practices), and vegetation (existing and potential).[2]

The three classes of prime forestlands in Leelanau County, as defined by the U.S. Department of Agriculture, are:[2]

1. "Prime timberlands" - Lands which are capable of producing 85 cubic feet (about one standard cord) per acre per year in fully stocked natural stands. These lands are nationally significant.
2. "Unique timberlands" - Lands which are not capable of producing 85 cubic feet per acre per year but are growing substantial quantities of specific high value species or species capable of producing specialized wood products. Some examples of unique timberlands in other states are those which support black walnut plantations, pecan, and Atlantic white cedar.
3. "Timberlands of local importance" - Lands which are not identified as having national or regional significance but are important to local communities. These lands were identified by local resource groups.

Prime timberlands occupy most of the eastern half of the Peninsula, while timberlands of regional importance mainly occupy the western half of the Peninsula. There are two clusters of unique timberlands. One is in

Solon Township south of Victoria Creek, the other is in Bingham Township along Mebert Creek and Lake Leelanau. Both of these areas are not prime timberland, but support highly productive tracts of northern white cedar. Leelanau County is the only county in a 13 county area of northwest Michigan to have any unique timberlands.

Commercial Forest Act

The Commercial Forest Reserve Act, PA 94 of 1925, MCL 320.301, *et seq*, was adopted to encourage reforestation and proper forest management on commercial forest lands. Properties are enrolled in the commercial forest management program on a property tax incentive basis. The owner must in turn maintain the land as commercial forest, with some limited cutting allowed, and open the land to public hunting and fishing. Land is enrolled in the program for a period of twenty years.

There are 2,368 acres of land in Leelanau County enrolled in this program. Most of it is located in Cleveland, Kasson, and Empire Townships, with some large areas in Centerville and Suttons Bay Townships (see Table 2-6).

Woodland Types

Woodlands cover approximately 45% of Leelanau County, and consist predominantly of upland hardwoods (see Figure 2-11). Wooded areas on moraines and outwash plains are mostly maple, beech, elm, and aspen, with some black cherry, ash, basswood, birch, hemlock, white pine, and red pine are intermixed. Wooded areas on dunes and sandy lake plains are mostly jack pine, white pine, red pine, soft maple, aspen, and juniper. Swampy lowland areas contain white cedar, balsam fir, and black spruce, intermixed with elm and soft maple.

The western half of Leelanau County is covered by very large contiguous tracts of upland hardwoods, especially surrounding Glen Lake and the Sleeping Bear Dunes National Lakeshore. There are also some large tracts of conifers in southern Empire and Kasson Townships. Aspen and birch are scattered throughout the Peninsula, however a large contiguous tract covering over 750 acres is located in Sections 11, 12, 13, and 14 of Glen Arbor Township.

Table 2-6
COMMERCIAL FOREST ACT LANDS

Township	Acres Enrolled
Centerville	137
Cleveland	927
Empire	638
Kasson	403
Leelanau	50
Solon	59
Suttons Bay	154

Woodlands are mostly scattered in the eastern half on the County, with some large tracts along Grand Traverse Bay and along Cathead Bay on Lake Michigan. Coniferous and aspen/birch wooded areas tend to be less than 100 acres per tract in this portion of the Peninsula, while contiguous hardwood tracts range in size from 20 to 800 acres.

SAND AND GRAVEL

Sandy soils, some containing gravel below the subsoil, are abundant in Leelanau County and have good potential for sand and gravel mining. Three of the eight soil associations in the County have calcareous (containing calcium or lime) sand and gravel deposits at depths of 25 to 35 inches. Those soil associations are Kalkaska-East Lake, Kiva-Mancelona, and Leelanau-Mancelona. These soil associations are generally found in areas of the Peninsula south of Glen Lake, Lime Lake, and Lake Leelanau. Figure 2-1 shows locations of soil associations in the County.

EMERGING ISSUES

Fragmentation of Resource Lands

Since the 1960's, non-resource based residential development has been occurring

at an increasing rate in Leelanau County, threatening to replace resource based land uses, such as farming, forestry, and sand/gravel extraction. The division of farm and forest lands into small tracts is the leading threat to resource lands, with irreversible results.

No uniformly accepted standards of economically viable parcel sizes are available, but timber buyers often enter into cutting contracts only on parcels 40 acres or larger, and 15 to 25 acres of prime agricultural land is often the minimum amount sufficient for growing high value crops such as vegetables, tree, vine, or berry fruits. Farming grain crops requires much larger parcels often totaling 1,000 acres or more. Dairy farms often require a minimum size of 300 acres.

Woodlands which are not commercial forest land are also a valuable resource. They reduce storm water runoff, prevent soil erosion, and lend substantially to the rural character of the Peninsula. Yet as land is split for residential development and homes are built, contiguous tracts of woodland become smaller and more scattered. Many hardwood trees take fifty years or longer to mature and may be lost forever. Preserving large tracts of woodlands in Leelanau County is especially important because of highly erodible soils and in significance of tourism in the local economy.

Development regulations aimed at preventing the loss of natural resources can sometimes have unintended impacts. Such impacts may result in undesirable land use and resource patterns. For example, large minimum lot sizes intended to protect farmland and forestland in many parts of Michigan have, through an unintended process of fragmentation, ultimately decreased the viability of such areas for resource-based uses. Leelanau County still has many resource lands intact and viable. Increasing pressure for new development threatens these areas and presents a challenge to local officials and citizens to devise effective techniques for controlling land division and growth, especially in areas valuable for farming, forestry, or sand and gravel mining.

ISSUES FOR FURTHER DISCUSSION

Who has the responsibility of making sure valuable, non-replaceable resource lands do not become endangered? The state has some responsibilities, but local governments are ultimately responsible for land use planning in their area.

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1. **Michigan Hydric Soils List**, USDA Soil Conservation Service.
2. **Leelanau County Forest Soils Report**, Northwest Michigan Prime Forestlands Identification Project. 1982.

Chapter 3

ENVIRONMENTALLY SENSITIVE AREAS

INTRODUCTION

Leelanau County has many environmentally sensitive areas including critical sand dunes, high risk erosion areas, wetlands, floodplains, unique vegetation, and unique landforms. Sand dunes, river and lake shores, and the Great Lakes shoreline are attractive places for residential development. However, they pose health and safety hazards and are very susceptible to damage. Development in these highly sensitive areas eventually causes damage to other components of the natural environment, including lakes and streams, farmlands, and forests.

Proper management of environmentally sensitive areas is critical to maintaining the natural environment and economic base of the Peninsula and protecting the public health, safety, and welfare. Identifying and describing where these areas are located is the first step to protecting sensitive areas. This chapter provides background information necessary to initiate or update measures aimed at protecting environmentally sensitive areas.

FLOODPLAINS

Overview

Areas adjacent to the Great Lakes, inland lakes, creeks, streams, and rivers are susceptible to periodic flooding that can cause extensive damage to buildings and can pose a substantial threat to public health and safety. The flooding may occur frequently or only after major storms. The 100 year floodplain is the area that would be inundated, or covered with water, during an Intermediate Regional Flood; one which occurs approximately once every 100 years. Maps of 100 year flood boundaries have been prepared for several communities in Leelanau County, including Centerville, Cleveland, Elmwood, Glen Arbor, and Leelanau Townships, and the villages of Suttons Bay and Northport (see Figure 3-1).

Flood Prone Locations

Flood prone areas in Leelanau County include all of the Grand Traverse Bay shoreline, all of the Lake Michigan shoreline, shorelines of inland lakes, and locations along several creeks and streams. The 100 year flood zone along Lake Michigan extends from 250 to 300 feet inland in most places. This is also the case along the shorelines of most of the inland lakes. The Grand Traverse Bay shoreline has 100 year flood areas extending as much as 1000 feet inland, especially in the vicinity of Northport Point. The creeks and streams with small flood zones (approximately 250 to 300 feet on each side) are listed in Table 3-1 below.

Table 3-1
FLOOD PRONE CREEKS AND STREAMS

Name	Location
Belangers Creek & Bass Lake	South Leelanau Twp. / Suttons Bay Twp.
Belnap Creek	Elmwood Twp.
Cedar Creek & Cedar Lake	Elmwood Twp.
Brewery Creek	Elmwood Twp.
Northport Creek	Northport
Shalda Creek	Cleveland Twp.
Shetland Creek	Cleveland Twp.

Floodplains on inland areas of the Peninsula are small because Leelanau County is not traversed by any major rivers. Furthermore, the Peninsula has hilly terrain which facilitates runoff drainage, large lakes which can hold enormous amounts of water without flooding, and a thick layer of highly permeable soils.

Development in Floodplain Areas

The Federal Flood Insurance Program has established guidelines for use and development of floodplain areas. Those regulations indicate that development in floodplains should be restricted to open space, recreational, or agricultural uses. Installation of public utilities and permanent construction for residential, commercial, or industrial uses should not occur in floodplain areas.

Lack of planning and regulation has already led to considerable development in floodplain areas around Michigan (mostly in large, older metroploitan areas), and the costs incurred by governments and landowners have been enormous. Floodplains are much more suitable for open space or wildlife habitat than for urban type residential, commercial, or industrial land uses. Thus, platting or other land division should be discouraged or prohibited in floodplains, and access roads should be constructed in upland areas.

WETLANDS

Overview

Wetlands include marshes, swamps, and usually other low-lying areas between dry land and open water. These areas are typified by poor drainage, standing water, and distinct types of vegetation. They are important community resources for several reasons. Wetlands provide a filter to keep inorganic materials out of the water supply, filter sediments from entering lakes and streams, act as a sort of "sponge" to retain water during dry periods, and hold water during floods. One acre of marsh is capable of absorbing 300,000 gallons of water. Wetlands provide this holding capacity inexpensively. If destroyed they can usually be replaced only with expensive structural public improvements.

Location

A small portion of Leelanau County can be characterized as wetlands (approximately 18,500 acres according to a 1990 Leelanau County Planning Department land cover/use inventory). These wetland areas are primarily associated with the creek channels and lakes located within the Peninsula, as indicated on Figure 3-2. Most of the wetlands exist in a relatively large, contiguous area south and west of South Lake Leelanau in Centerville, Kasson, and Solon Townships, known as the Cedar and Solon Swamps. Other concentrations of wetlands are located along Mebert Creek and Lake Leelanau in Bingham Township, and near Leo Creek south of Suttons Bay. The remainder are scattered throughout the Peninsula. Some wetlands, such as fens or meadows, do not look very wet and may not be wet a large part of the year. Most of these areas are seasonally flooded – usually in the spring and fall, and in the summer they are often without standing water, although the organic soil usually stays near saturation.

Wetlands Protection Act

Because wetlands are a valuable natural resource, they are protected by PA 203 of 1979, MCL 281.701 *et seq.* PA 203 requires that permits be acquired from the Michigan Department of Natural Resources (DNR) prior to altering or filling a regulated wetland. The Wetland Protection Act defines wetlands as:

> *"land characterized by the presence of water at a frequency and duration sufficient to support and that under normal circumstances does support wetland vegetation or aquatic life and is commonly referred to as a bog, swamp, or marsh and is contiguous to the Great Lakes, an inland lake or pond, or a river or stream."*[1]

Regulated wetlands include all wetland areas greater than 5 acres or those contiguous to waterways. Wetlands which are hydrologically connected (i.e. via groundwater) to waterways are also regulated. Activities exempted from the provisions of the Act include farming, grazing of animals, farm or

stock ponds, lumbering, maintenance of existing nonconforming structures, maintenance or improvement of existing roads and streets within existing rights-of-way, maintenance or operation of pipelines less than six inches in diameter, and maintenance or operation of electric transmission and distribution power lines.

Permits will not be issued if a feasible or prudent alternative to developing a wetland exists. A map of wetlands based on Leelanau County's land use/cover inventory are illustrated on Figure 3-2. Table 3-2 shows the land use/cover codes pertaining to regulated wetlands in the area. Most areas of hydric soils in Leelanau County correspond to wetlands.

Table 3-2
WETLAND LAND COVER/USE CODES

Code	Description
414	Lowland Hardwood
423	Lowland Conifer
611	Forested Wetland
612	Shrub Wetland
621	Aquatic Bed
622	Emergent Wetlands

HIGH RISK EROSION AREAS

Erodibility of Great Lakes Shoreline

Portions of the Lake Michigan and Grand Traverse Bay shorelines in Leelanau County are very susceptible to wind and water erosion during storms and high lake levels due to resultant wave action. These shorelines are continuously changing, particularly in response to fluctuations in lake levels. What appears to be a recent problem to shoreline property owners could be more accurately regarded as a natural process which has been occurring for several thousand years, but which affects and is affected by the actions of man.[2]

The major shore types that have evolved within the erodible portion of the Great Lakes shoreline, which includes all of Leelanau County, are as follows:[2]

1. *Low erodible bluffs* range in height from 9 to 30 feet and are mainly composed of glacially derived gravels, sands, silts, and clays. They are interspersed among the other shore types. Drainage and slope stability are problems commonly associated with this shore type.

2. *High erodible bluffs* are those greater than 30 feet in height and composed of glacial materials. Drainage and slope stability are problems commonly associated with this shore type.

3. *Low erodible plains* refers to those unconsolidated stretches of shoreline less than 9 feet in height. They are commonly associated with wetlands and are subject to erosion when exposed to wave attack. Flooding is a common problem.

4. *Sand dunes* present special considerations for development and protection. Low dunes are found on all the Great Lakes, but high dunes reaching over 450 feet are found primarily along the eastern Lake Michigan shoreline, where human activity and wind erosion are the primary concerns.

5. *Wetlands* are primarily confined to large bays such as Green Bay and Saginaw Bay, and other shallow areas of the lakes such as Lake St. Clair and the western end of Lake Erie. Dredging and filling operations have reduced wetlands and the shore protection they provide.

Shore Types 1 and 2 above are the most likely areas of Leelanau County shoreline to be highly erodible.

Locations

All of the five erodible shore types are found in Leelanau County. Low erodible bluffs are located primarily along Grand Traverse Bay, while high erodible bluffs (for example, Empire Bluffs) exist mostly along Lake Michigan shoreline. Sand dunes are located exclusively along Lake Michigan. Examples of low erodible plains in the County are Sleeping Bear Bay, Good Harbor Bay, and Northport Point, as well as North Fox and South Fox Islands. Coastal wetlands are scattered and only exist in very small tracts. Some shore wetlands exist in the Lighthouse Point area of Leelanau Township.

Michigan DNR designated high risk erosion areas are shown on Figure 3-3.

Types of Shore Erosion

The erodible Great Lakes shore types in Leelanau County are subject to four principal types of degradation: wave action, groundwater seepage and bluff slumping, surface runoff, and wind erosion. These types of shore erosion may occur individually or in some combination. Surface runoff and wind erosion are the processes most easily controlled by vegetation. Bluff slumping occurs when groundwater, confined by an impervious layer such as clay, seeps from underneath a sand bluff and erodes away the foundation of the bluff.

The primary agents of slope surface erosion are rain, surface runoff, and wind. All of these are capable of removing sediment from unprotected slopes and, unless they are controlled, can result in large losses of materials over an extended period of time. These natural processes thus pose hazards to public health, safety, and welfare.

Shorelands Protection and Management Act

The Shorelands Protection and Management Act, PA 245 of 1970, MCL 281.632 *et seq*, was enacted in part to identify areas where high risk erosion hazards exist. It established a framework for designating them and for instituting measures to minimize property losses resulting from natural forces of erosion. High risk erosion areas are defined as areas of the shore along which bluffline recession has proceeded at a long term average of 1 foot or more per year. Portions of the Lake Michigan and Grand Traverse Bay shorelines in Leelanau County have been designated as high risk erosion areas. Within the designated area, shown on Figure 3-3, alteration of the soil, natural drainage, vegetation, fish or wildlife habitat, and any placement of permanent structures, requires a Michigan DNR review and permit, unless the local unit of government has an approved high risk erosion area ordinance.

SAND DUNES

Overview

The sand dunes along Lake Michigan in the Leelanau County represent a unique and fragile physiographic formation and ecosystem that is very susceptible to wind and water erosion, and destruction due to careless use or development. Wind is the force responsible for building the dunes and likewise, it is capable of shifting and/or removing the sand dunes when they are left unprotected. In dune areas where natural vegetation has been disturbed by development or traffic, winds have eroded the unprotected fine-grained sands and transported them elsewhere.

Sand Dune Protection and Management Act

High relief sand dune areas in Leelanau County are protected by the Sand Dune Protection and Management Act, PA 222 pf 1976, MCL 281.651 *et seq*, as amended. Recent legislation (PA 147 & 148 of 1989) provides for additional protection of critical dune areas. Under these Acts, all proposed residential, commercial, or industrial uses, multifamily uses of more than 3 acres, and any use which the local planning commission or the DNR determines would damage or destroy features of archaeological or histori-

cal significance must ultimately be approved by the State. The law prohibits surface drilling operations that explore for or produce hydrocarbons or natural brine as well as mining activities (except in the case of permit renewals). The legislation also imposes certain standards on construction and site design in critical dune areas. The Michigan Department of Natural Resources administers a permit program which can be "taken over" by local governments which administer local zoning patterned after the state law.

Critical Dune Areas

Several areas in Leelanau County have been identified by the Michigan Department of Natural Resources as critical dune areas, subject to protection under the Sand Dune Protection and Management Act. The designated critical dune areas are shown in the shaded region of Figure 3-4, and are all located along Lake Michigan. The largest of these areas are the Sleeping Bear Dunes and Empire Bluffs, located in Empire and Glen Arbor Townships. Other large critical dune areas are located at Pyramid Point, Good Harbor Bay, Cathead Bay, and on South Manitou Island.

UNIQUE PLANTS AND ANIMALS

The Michigan Department of Natural Resources maintains an inventory of unique natural features, and has compiled a map of natural features of Leelanau County (see Map 4-5). The information is not specific, due to the need to protect species from depletion, but it does provide general locations. The inventory shows that the Peninsula has a variety of unique plants and animals, concentrated primarily in the sand dune areas along Lake Michigan, with some located in and around Lake Leelanau and Glen Lake. Some of these plants and animals may be the only ones found in Michigan.

Some plant species in Leelanau County are officially recognized as either threatened or endangered. The Michigan Monkey Flower exists in what is possibly the most significant population in the state, located in the Glen Lake watershed area. The Monkey Flower is on the federal endangered species list, while the Pitcher's Thistle, which is found along the entire Lake Michigan shoreline of the Peninsula, is on the federal threatened species list. Numerous other plant species found in sand dunes or along Lake Michigan are listed as being of special concern, threatened, or endangered under the Michigan Endangered Species Act. This is yet another reason to protect sand dunes and Lake Michigan shorelands from excessive and damaging development.

UNIQUENESS OF NATURAL FEATURES

Leelanau County contains a combination of natural features not found in any other part of Michigan, the United States, or even the world. Some of these features include unique suitability for producing orchard fruits, large sand dunes, a unique coastal environment, diverse topography, scenic vistas, and high quality inland lakes. Grand Traverse Bay is another natural feature that is likely not duplicated anywhere else in the world. Yet all of the elements which make Leelanau County a unique place are fragile and susceptible to irreparable damage from misuse and careless land development. The natural environment of the area cannot be replaced or duplicated, and if lost, it will be lost forever.

EMERGING ISSUES

Federal, state, county, and local governments all have a role on protecting environmentally sensitive areas. The federal role has been to protect areas of national significance, in a consistent nation-wide manner, when states have failed to do so on their own. The state role is to provide a minimum level of protection to sensitive areas and enable county and local governments to supplement legislated protection of those areas with their own policies or regulations. The county government role has been to assist and advise local governments within the county and to regulate where and when local governments

do not. Local governments are the most at stake when it comes to ensuring that environmentally sensitive areas are protected consistent with local needs and local initiatives to protect community character and resources.

Local governments typically have not paid much attention to degradation of their natural resources until a problem situation arises, or they have relied completely on the state and federal systems to do it for them. Taking a reactive stance on environmental issues at the local level is usually inadequate to reverse such problems; indeed, most of them cannot be physically changed. It is not in local government's interest to rely solely on state and federal policies to protect their environmental interests. Instead of the traditional hands-off approach, a proactive agenda is necessary for communities to ensure that their natural resources will be there for future generations to use.

Other emerging issues include but are not limited to:

- Environmental protection versus development - or development which compliments and protects the environment.
- The base of technical information and expertise for local administration of environmental and/or land use regulations (zoning) to protect environmentally sensitive areas.

ISSUES FOR FURTHER DISCUSSION

To what extent should local governments or the County regulate development in high risk erosion, sand dune, and wetland areas? The state currently administers programs for each type of area, but local governments can have the authority if they want to use it and can develop ordinances which meet Michigan Department of Natural Resources approval.

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1. **Michigan Shorelands Protection and Management Act**, PA 203 of 1979, MCL 281.701 et seq.
2. **Vegetation and its Role in Reducing Great Lakes Shoreline Eroison: A Guide for Property Owners**, Michigan Sea Grant College Program, 1988.

Chapter 4

AIR & WATER QUALITY

INTRODUCTION

Air and Great Lakes water quality in Leelanau County continues to decline due largely to land use activities hundreds of miles away within the Lake Michigan Basin. In addition, airborne pollutants arrive at the Great Lakes from thousands of miles away.

Inland lakes throughout the Peninsula are rated as having high water quality (oligotrophic). However, many of those lakes are at borderline mesotrophic conditions and recent studies suggest that increased nutrient loading from agricultural runoff, faulty septic systems, and lawn fertilizers will degrade surface water quality. Perhaps the most alarming studies are those conducted for Houdek Creek and North Lake Leelanau, which suggest the possibility of rapidly deteriorating water quality in those areas.

Many streams and creeks in Leelanau County are designated trout streams, and provide high water quality and habitat for some species of fish. Recent golf course and resort developments have caused slight damage to area streams, but this has been shown to be very limited due to the implementation of best management practices (BMP's) at these new developments (according to recent studies by the Michigan Department of Natural Resources referenced on pages 5-7 of this chapter). Houdek Creek, north of N. Lake Leelanau, continues to be an area of concern due to high nutrient concentrations.

Groundwater is probably the most threatened resource in the County. The depth of glacial drift material, combined with highly permeable sandy soils and the continued presence of agricultural activities which use a variety of chemicals in day-to-day operations, holds high potential for future problems. In addition, nearly 60% of the County relies on unconfined aquifers (those without an impermeable layer separating them from the ground surface) for water.

This chapter provides information on the existing and possible future conditions of air and water quality in Leelanau County. Much of the material is derived or excerpted from scientific studies conducted by the Michigan Department of Natural Resources, the Leelanau Conservancy, the US Environmental Protection Agency, and Michigan State University. Much of the source information is very technical. It is conveyed in as non-technical a manner as possible in this chapter. Some of the most significant information in the following sections is that which relates land use and management practices to air and water quality. Land use, if not appropriately controlled or managed, can have enormous negative impacts on the area's air and water quality.

AIR QUALITY

Sources of Air Pollution

Preliminary results of a multi-state air pollution study by the U.S. Environmental Protection Agency suggest that major concentrations of smog are crossing Lake Michigan from the Greater Chicago area and significantly heightening ozone levels along shoreline areas of Michigan. The preliminary results of a temporary ozone monitoring station, established as part of the EPA study near Empire, suggest federal standards were exceeded three times between June and August of 1991. The Garden Peninsula, northwest of Leelanau Peninsula in the Upper Peninsula exceeded federal ozone standards during the summer of 1991 as well (see Figure 4-1). Federal sanctions can be levied upon communities which exceed ozone standards in excess of one violation per four year average.

Ozone is a pollutant formed when certain

vehicular and industrial organic pollutants react with nitrogen in the presence of heat and sunlight. The ozone gas is an irritant and causes respiratory problems in humans. Industrial emissions from urban centers outside of the region and Michigan pose the greatest threat to air quality in Leelanau County.

Industrial and vehicular emissions are the principal local causes of air pollution. Though the future extent of industrial development in or near the County is unknown, vehicle emissions can be expected to increase with population growth, tourism, and expansion of retail and commercial services (increasing the number of vehicle trips, vehicle miles, and congestion). Reductions in the permitted level of vehicular emissions which may be brought about by new federal standards (currently being developed) may be offset by an increasing number of vehicles in the County.

The contributing factors which could negatively affect future air quality in Leelanau County thus come from three possible sources:

1. Any new large heavy industrial complex or incinerator in or near the County
2. Many more vehicles using the roads
3. Air pollutants which migrate long distances.

U.S. Environmental Protection Agency Monitoring Activity[1]

Five platforms and towers covered with sophisticated measuring equipment have been set up by the U.S. Environmental Protection Agency and Environment Canada. This equipment forms the foundation for up to a 35-station network that will determine how air pollution affects the world's largest freshwater basin. The towers are placed at remote locations around the Great Lakes and represents the most extensive air-monitoring system ever built. Equipment at the five monitoring stations in the region will be able to determine how long a compound has been in the air and whether it was generated by industry, agriculture, motor vehicles or some other source.

The EPA and its Canadian counterpart, Environment Canada, selected five sites for the first "master stations" - Eagle Harbor, Mich.; Sleeping Bear Dunes, Mich.; Burnt Island, Ont; Point Petre, Ont, and Sturgeon Point N.Y. (see Figure 4-1). Each station includes a 10-by-20-foot platform for air and precipitation samplers and a 30-foot tower for meteorological equipment.

The new air-monitoring network is intended to provide more accurate information that governments need to reduce contaminants in the lakes, in fish and, ultimately, in humans. After a year of fine-tuning the sophisticated devices, the EPA and Environment Canada will begin reporting measurements of air contributions to Great. Lakes pollution. The agencies plan to build five or six more satellite stations on each of the Great Lakes, for a total of up to 35.

Michigan Department of Natural Resources Monitoring Activity

The Air Quality Division of the MDNR does not maintain a permanent monitoring site for Leelanau County. As a result, no long term air quality statistics are available for the Peninsula. Counties without a monitoring station are presumed to be in compliance with air quality standards (except for ozone, which is a regional pollutant). The nearest counties to Leelanau which have been monitored, though not regularly nor for all pollutants, are Charlevoix and Grand Traverse. Findings in both locations have always attested to high air quality levels.

WATER QUALITY

There are no health advisories against full body contact in Peninsula waters, nor any advisories against eating fish caught in any lake or stream within the County. There are health advisories against consumption of lake trout and salmon caught in Lake Michigan or Grand Traverse Bay, but these apply to all Lake Michigan waters.

Table 4-1
LAKE TROPHIC STATE CHARACTERISTICS

Characteristic	Oligotrophic	Mesotrophic	Eutrophic
Nutrient Levels	Low	Medium	High
Organic Matter Content	Low	Medium	High
Biological Productivity	Low	Medium	High
Lake Age	Young	Middle	Old
Water Transparency	High	Medium	Low
Oxygen Depletion in Hypolimnion	No	Yes	Yes
Average Depth	Deep	Moderate	Shallow
MDNR Trophic State Index (TSI)	0-38	39-48	49-100

Source: Michigan Department of Natural Resources[2]

Water bodies identified by the Michigan Department of Natural Resources as having non-point source pollution impacts are the Crystal River, Glen Lake, Lake Michigan, Little Traverse Lake, South Bar Lake, Beaudwin Creek, Belanger Creek, Belnap Creek, Cedar Run Creek, Grand Traverse Bay, Houdek Creek, Mebert Creek, North and South Lake Leelanau, Stricker Lake, Victoria Creek, and Northport Bay. Impacts of non-point source pollution include excessive weed growth, sedimentation, turbidity, depleted fish communities, and odors. Typical non-point sources are urban runoff, irrigation, construction site erosion, agricultural practices, animal wastes, golf courses, mining and drilling, and streambank erosion.

Inland Lakes[2]

Lakes are generally classified by their physical, chemical and biological characteristics into one of three trophic categories (oligotrophic, mesotrophic, eutrophic). The tropic state is a measure of a lake's biological productivity and includes such factors as nutrient levels, organic matter content, and water transparency (see Table 4-1). Although there are several methods used to classify lakes, the Michigan Department of Natural Resources (MDNR) utilizes the Trophic State Index (TSI) developed by Carlson (1977). The TSI numbers are derived from calculations based on Secchi disc transparency, chlorophyll a, or total phosphorus values, and can range from zero to 100. The higher the number, the higher the lake productivity.

Eutrophication, or lake productivity, progresses through a continuum with no absolute separation between oligotrophic, mesotrophic and eutrophic conditions. In an attempt to categorize lakes, however, individuals generally assign a range of TSI values for each classification category. For example, oligotrophic lakes generally have TSI values less than 38 to 40, while eutrophic lakes generally have TSI values greater than 48 to 52. Mesotrophic lakes fall somewhere in between.

Since 1982, re-evaluation of the literature and personal knowledge of Michigan lakes prompted the MDNR, Inland Lakes Management Unit, to modify TSI value classifications somewhat to better reflect conditions of Michigan lakes. Current TSI values associated with the classification categories are the following: oligotrophic - less than 39; mesotrophic - between 39 and 48; and eutrophic - greater than 48.

Although comprehensive programs of water quality testing have only recently been initiated, data generated over the past 15 years document relatively high water quality levels throughout Leelanau County. This is particularly true for inland lakes. Of the eight major inland lakes evaluated by the Michigan

Table 4-2
INLAND LAKE WATER QUALITY

Lake Name	TSI Rating	Trophic State	1988 Lake Water Quality Assessment
Cedar	37	Oligotrophic	Threatened
Glen	25	Oligotrophic	OK
Lime	31	Oligotrophic	OK
Little Glen	37	Oligotrophic	OK
Little Traverse	33	Oligotrophic	Impaired
North Lake Leelanau	36	Oligotrophic	OK
School	47	Mesotrophic	OK
South Lake Leelanau	37	Oligotrophic	Impaired

Source: Michigan Department of Natural Resources[2]

Department of Natural Resources, Surface Water Quality Division, since 1982, all but one have been classified as oligotrophic (see Table 4-2).

Septic System Outflow Into Lakes

A 1983 study by the Northwest Michigan Regional Planning and Development Commission estimated that a total of 106 lbs/yr of phosphorus were entering North Lake Leelanau from septic system outflow. This information was based on examination of cladophora growths at 303 home sites on the lake. Leland Township contracted with the Leelanau Conservancy to complete another cladophora study in the summer of 1990. That survey showed a 5 percent increase in the number of houses on the lake, coupled with a 111.3 percent increase in the number of sites with algal growths. A survey questionnaire, done in conjunction with the algal survey, also indicated that 66 percent of septic systems along the lake are within 100 feet of the shoreline, while 38 percent of the systems are 30 years old or older.

The septic system and holding tank methods of sewage disposal are presently the only means of sewage disposal utilized throughout most of the Peninsula. On-site sewage disposal systems primarily rely on the upper layers of the soil to treat waste material. Many of these systems are also in close proximity to shorelines and are very likely close to groundwater elevations and thus are likely to leach nutrients into the nearby water body. Even for septic systems which are initially designed and installed correctly, they must be maintained and cleaned out at appropriate intervals to function properly. Studies (recently conducted locally by The Leelanau Conservancy and the U.S. Department of Agriculture) have shown, however, that many septic systems are not maintained for long periods of time, and thus are not operating properly, in effect acting as a sewage conduit to high quality surface waters. A recent study of Glen Lake indicated leaking septic systems not to be a major source of pollution in that lake.

Impacts of Agricultural Chemicals

A significant portion of the land with specific orchard and specialty crop/pesticide use combinations within the County (over 90%) is rated as having high probability for runoff (high probability pesticides and other agricultural chemicals will leave the site with runoff). Most of these pesticides carry label statements warning of toxicity to aquatic wildlife such as fish and aquatic invertebrates. Therefore, runoff of such chemicals into surface waters is a primary concern, especially if the waters are of high value for fishing and recreational use - as are the Peninsula's lakes and streams.

Streams and Creeks

Current conditions of the Peninsula's streams and creeks do not uniformly suggest the same high quality. Studies prepared during the past ten years and as recently as 1990 have identified streams of high quality, including the Crystal River, as well as streams of lower quality, such as Houdek Creek, which are carrying elevated levels of nitrates and phosphorous. Relatively speaking, the water quality of rivers and streams in Leelanau County is very high. Nearly all the streams and major tributaries are designated trout steams.

Trout require clean, cold, oxygenated water to survive and are a good indicator species of water quality. The only stream segments not designated as trout streams include Shalda or Sucker Creek at the Narada Lake outlet and the Crystal River between Fisher Dam and Glen Lake. No rivers or streams in the County have lost *"trout stream"* designation.

Recent MDNR Studies

The following sections are edited summary portions (results) of staff reports by Michigan Department of Natural Resources Personnel. These are biological and water quality studies of area creeks and streams by the Surface Water Quality Division. The most recent one was for Mebert, Cedar Run, and Victoria Creeks in August, 1990. The least recent is the Crystal River study, dated July, 1987.

MEBERT, CEDAR RUN, AND VICTORIA CREEKS[3]

Mebert Creek, upstream of the golf course construction, was categorized as good (slightly impaired) in fish community, macroinvertebrate community and physical habitat. Mebert Creek, downstream of the golf course, was categorized as fair (moderately impaired) in fish community and habitat and good in macroinvertebrate community structure. The lower fish and habitat metric scores at the downstream location were probably caused by the direct removal of instream cover (logs and other stream channel debris were observed along the banks). It is likely that the removal of instream cover negatively affected the fish community, and the macroinvertebrates to a lesser degree, downstream.

Bottom deposition was similar at both Mebert Creek stations. This suggests that the BMPs implemented in golf course construction were effectively preventing sedimentation.

Cedar Run Creek was categorized as good (slightly impaired) in fish community and habitat condition and fair (moderately impaired) in macroinvertebrate community. In Cedar Run Creek, fish community and habitat metric scores were the highest, and the macroinvertebrate metric score was the lowest of the four stations surveyed. Sand deposition, covering greater than 50% of the bottom substrate, may account for the reduced macroinvertebrate metric score. The trout farm discharge was not causing any readily apparent effects at Cedar Run Creek.

Victoria Creek was categorized as good (slightly impaired) in fish community, fair (moderately impaired) in macroinvertebrate community and poor (severely impaired) in habitat condition. In the vicinity of Gatzge Rd., Victoria Creek flows through wetlands surrounded by steep, sandy knolls. The stream banks at this station were moderately unstable with numerous signs of erosion. This suggests that seasonal high flows may add significantly to the stream's sediment load. The bottom substrate was dominated by shifting sand and the lack of suitable substrate could explain the reduction in benthic macroinvertebrates such as ephemeropterans, trichopterans, and plecopterans.

Water chemistries indicate that phosphorus and nitrogen levels at all six stations were not elevated and are typical of second and third order northern temperate streams. A sample of the trout farm effluent discharged upstream of the test site on Cedar Run Creek contained higher concentrations of phospho-

rus and ammonia nitrogen when compared to the data from other stations. However, the chemical data show that nutrient levels at Cedar Run Creek were similar to those at the other test sites.

Sand deposition (sedimentation) covered over 50% and 70% of the bottom substrate in Cedar Run and Victoria Creeks, respectively. Less than 30% of Mebert Creek was affected by sand deposition. Macroinvertebrate metric scores were lower at Cedar Run and Victoria Creeks than at Mebert Creek and this may reflect deposition-related habitat losses. With water quality being similar at all stations, it appears that sand deposition may be the primary cause of the macroinvertebrate community and habitat impairment in these South Lake Leelanau tributaries (i.e. these streams are very susceptible loss of fish habitat due to increased sedimentation).

CRYSTAL RIVER[4]

Good stream quality was present in the Crystal River based upon the biota, habitat and flow conditions found at the three sampling sites. The substrate varied throughout the sampling area with clean gravel in the higher velocity stretches, and sand and muck in low velocity areas. The estimated flow during this study was approximately 40 cfs. Fish collected from the Crystal River during this study were primarily those from the sunfish, bass, and minnow families. The benthic macroinvertebrate community was diverse, and included representatives of the mayfly, stonefly and caddisfly families.

The Crystal River varied greatly in habitat and substrate type from its origin at Glen Lake to the mouth at Lake Michigan. Station 1 (midway between Fisher Lake and Lake Michigan) was characterized by riffles and pools, with a primarily gravel substrate. River velocity was slower at Station 2 (at M-22 and County Road 675) and water depth fairly uniform without riffle areas. Station 3, near the mouth, was located within the Homestead Resort. River velocity and substrate conditions were similar to Station 2.

The Crystal River is categorized as a coldwater stream capable of supporting fish species in the salmon family. There were no fish species from this family collected during the survey. The fish communities were similar at all stations comprised primarily of sunfish, creek chubs, com and darters. The cover provided by the abundance of macrophtyes at Station 2 probably accounted for the increased number of fish species collected at this location.

The number of macroinvertebrate taxs were similar at all stations sampled, and indicative of good water quality as evidenced by the type and diversity of organisms found. Representatives of the mayfly and caddisfly groups were absent from Station 2 due to the lack of suitable substrate.

Nutrients in the water at all stations were low. There were slight increases in nutrients at Station 3, possibly due to the change in surrounding land use from forest to resort.

UNNAMED STREAM (BREWERY CREEK), GREILICKVILLE[5]

A stream survey was conducted on an unnamed tributary to West Grand Traverse Bay in the vicinity of Greilickville in 1989. The objective was to determine if there were petroleum related compounds in the water or sediments of the tributary. Petroleum related compounds were found in the sediments but not the water. Benzene, toluene, and xylene isomers were detected in sediment samples collected at Station 1 (where the stream crosses the railroad), and toluene was detected in sediment samples collected at Station 2 (where the stream empties into the bay). No petroleum compounds were detected in water samples from either station. The chemical, physical and macroinvertebrate data was not conclusive regarding the effects on the stream from petroleum compounds.

The groundwater in the vicinity of the study site is known to contain petroleum compounds. It was suspected that the groundwater was being vented to the surface

waters in the area. Analytical results of water samples taken at each station did not indicate any detectable concentrations of petroleum compounds. Sediment sample analyses detected benzene (21 ug/kg), toluene (33 ug/kg), and xylene isomers (7.3 ug/kg) at Station 1, and toluene (1.2 ug/kg) at Station 2. No other petroleum compounds that were analyzed for were detected in the sediments at either station. It should be noted that Station 2, which is downstream of the petroleum storage tanks, had only toluene in the sediments, and Station 1, which is upstream, had benzene, toluene, and xylene isomers in the sediments.

This study suggests that the sediments were contaminated with petroleum compounds, but the water analyses do not indicate that contaminated groundwater is being vented into the tributary. The stream characteristics and macroinvertebrate community data were not indicative of effects due to petroleum compounds. However, these results should not be considered conclusive regarding the effects of petroleum compounds on the stream.

ENNIS AND BELANGER CREEKS[6]

A biological survey of Ennis and Belanger Creeks was performed in August, 1988. The primary objective was to document background conditions prior to development of a golf course in the vicinity of the two creeks. Both creeks originate near the golf course development and flow to Grand Traverse Bay. Good stream quality was present in both Belanger Creek and Ennis Creeks based on macroinvertebrate and fish sampling results, water and sediment chemistry results, and habitat conditions.

This survey was conducted just prior to the onset of development of a golf course in the vicinity of Belanger and Ennis Creeks (Figure 1). Belanger and Ennis Creeks are both designated as trout streams.

Belanger Creek at station 1 (near Bass Lake) was characterized by pools and riffles with primarily sand and gravel substrates, respectively. The undercut banks and numerous deadfalls provided excellent habitat for fish. The estimated flow during this survey was 9 cfs. The benthic macroinvertebrate and fish communities of Belanger Creek were indicative of good stream quality. A total of 15 macroinvertebrate taxs were identified, including six mayfly, caddisfly, and stonefly taxa. The fish community included brook trout, with sizes ranging between 4"' and 11", and bluegill.

Ennis Creek was characterized by much lower flows than Belanger Creek, with flows ranging between 0.5 cfs and 0.8 cfs at stations I and 2, respectively. The substrate at station 1 (upstream, near golf course) was primarily sand with low quantities of organic material. The banks were only slightly undercut and little cover was available for fish. Two brook trout, with sizes ranging between 2" and 4", were collected at station 1.

The substrate at station 2 (near Grand Traverse Bay) was primarily silt. Undercut banks were present, but little overhanging cover for fish was available. A surprising total of 21 fish were collected from station 2, including brook trout ranging in size from 2" to 10" and salmon smolt betwen 2" and 4".

The reduced habitat quality at stations I and 2 of Ennis Creek as compared to Belanger Creek (i.e. lower flow, less habitat variety) was apparent in the results of the benthic macroinvertebrate sampling. Fewer caddisfly and mayfly taxa, and no stonefly taxa, were found in Ennis Creek. The overall benthic macroinvertebrate abundance was also lower at station 1 and 2 of Ennis Creek than station 1 of Belanger Creek.

The nutrients in the water at station I of Belanger and Ennis Creeks were very low. Sediment analysis for mercury at both stations showed no detectable concentrations.

Areas of Concern

HOUDEK CREEK[7]

The Houdek Creek watershed is located at the northeast corner of North Lake Leelanau and covers approximately 5,110 acres.

The watershed is also characterized by rolling terrain and steep slopes. There are two main branches of the creek, one running north through the northeast part of the watershed and the other running through the central part of the watershed. Both water courses are characterized with many small tributaries, which may or may not connect directly to the main branches, but will surface, then move underground and surface again at other locations. Both branches of the creek eventually merge into the main branch, which outlets into North Lake Leelanau through culverts on County Road 641. Use of the creek is limited to a small amount of fishing; however, since it is a major inlet into North Lake Leelanau, it directly influences the water quality of that lake.

About 2,865 acres, or 56 percent of the Houdek Creek watershed, are in agriculture. Of that acreage, some 1,180 acres are in general crop, mostly corn, small grain and hay; and 1,665 acres are in orchard crops, mainly tart and sweet cherries and apples. Another 1,645 acres of the watershed are in woodland types, with the majority of that being northern hardwoods and lowland conifers. Land uses in the watershed are as follows:

Land Use	Area	%
Agriculture	2,865 acres	56
Forestland	1,645 acres	32
Idle Land	555 acres	11
Residential	40 acres	0.8
Lakes and Streams	5 acres	0.01
TOTAL	**5,110 acres**	**100**

In the summer of 1990, the Leelanau Conservancy and Leland Township began water quality sampling in North Lake Leelanau, its major contributing streams, and its outlet. Results of these tests so far have shown a greatly elevated level of nitrates and phosphorus entering North Lake Leelanau from Houdek Creek and several other streams, compared to levels measured at the outlet of the lake at Leland River. Average levels of nitrates from samples taken in Houdek Creek for the summer of 1990 show 1.55 mg/l (milligrams per liter or parts per million), compared to nitrate levels in the outlet of Leland River averaging 0-.16 mg/l over the same period. In this same sample period, total phosphorus levels averaged 0.016 mg/l in Houdek Creek and 0.007 mg/l in Leland River. The level of nitrates entering the lake through Houdek Creek is thus nearly 10 times the level leaving the lake at the Leland River. Likewise, the phosphorus level entering the lake is averaging twice the level leaving the lake. According to results of the sampling that was done in the summer of 1991, this scenario is being repeated for at least 2 other major inlet streams on North Lake Leelanau.

There are about 10 homes in the Houdek Creek outlet area, all on septic systems or holding tanks. High cladophora levels measured in this area were believed to be directly related to leaky septic systems and lawn fertilization.

SOURCES OF THE PROBLEM:

Agricultural Chemicals

With 33 percent of the Houdek Creek watershed in orchard, the use of pesticides in orchard operations is an important consideration in surface and groundwater contamination. The problems with pesticides stem from storage of chemicals, filling station location, loading process, and disposal of the rinsate materials. The pesticides most used in orchards are insecticides, fungicides and miticides. These chemicals are generally rated as having small-risk potential for leaching and high-risk for runoff. Most of the chemicals carry label statements warning of toxicity to aquatic wildlife such as fish and aquatic invertebrates.

Runoff of such chemicals into surface waters is a significant factor influencing surface water contamination. The actual spraying of these chemicals does not pose a serious threat to groundwater contamination, as most of the pesticides used are foliar applied. Fo-

liar applied pesticides can be dropped one rating level, as the breakdown by sunlight of these chemicals is more rapid than microbial breakdown by soil microbes. However, if these pesticides are washed off by rainfall following an application, then another application may need to be made, which then increases the amount of pesticides being used, the potential for spills and the chances of improper disposal, along with leaching and runoff potential.

Another 23 percent of the creek watershed is in general crops where ground applied pesticides play a big role. Over 99 percent of all cropland soils in this area have a high potential for leaching of chemicals with a high rating. This is an important consideration because groundwater is hydrologically linked to Houdek Creek and North Lake Leelanau.

Cherry Cooling Pads

When tart cherries are harvested, they are collected in on-farm tanks and transported to on-farm "cooling pads". At the cooling pads, cherries are flushed with cold water to reduce their temperature, which maintains their quality until delivery to the processor. This process has two possible concerns associated with it: (1) soil erosion from the runoff water leaving the site; and (2) possible pesticide contamination if significant levels of pesticides are on the fruit and washed off. It is estimated that there are at least 25 cooling pad sites located within Houdek Creek Watershed. Any one of these sites could be contributing 50 tons or more of pesticide-laden sediment per year to Houdek Creek, based on data from the Agricultural Stabilization and Conservation Service.

Soil Erosion

Water and wind erosion on farmland reduces the productivity of the soil and makes it harder to grow quality crops. It also erodes surface soil, which carries with it the highest amount of nutrients and pesticides. As these soils reach the surface waters in the form of sediment, they not only clog waterways and ditches but also carry nutrients and pesticides. Using GIS data developed for Houdek Creek Watershed, it is estimated that approximately 13,000 tons of soil are eroded annually from cropland within the watershed. Of that amount, 8,210 tons are attributed to sheet and rill erosion, another 1,155 tons are from ephemeral gully erosion and the remaining 3,640 tons are from wind erosion. Also using GIS data, it has been determined that 5,400 tons of soil are eroded from lands within one quarter mile of the streams within Houdek Creek. Actual amounts of this sediment reaching the creek are estimated at 50 percent of the total, which equals 2,700 tons of soil reaching the creek annually.

Road Crossings

There are approximately 20 locations within the Houdek Creek Watershed where roads intersect the main creek or small tributaries of the creek. Many of these crossing sites can at times contribute a great deal of sediment to the creek from roadside erosion. A 1989 Michigan Department of Natural Resources assessment of several of the road/stream crossings in the Houdek Creek watershed indicated that a moving sand bedload in the creek was causing reduced biological activity. Without a stable bottom structure in the creek, fish and macro invertebrate propagation are being hindered.

NORTH LAKE LEELANAU[8]

The North Lake Leelanau watershed area covers approximately 18,380 acres, which includes Houdek Creek, the main inlet to North Lake Leelanau on the north end of the lake. The Houdek Creek Watershed covers 28% of the North Lake Leelanau watershed. The 3/4-mile long Leland River outlets the lake through a dam at Leland and into Lake Michigan. South Lake Leelanau flows into North Lake Leelanau at the "narrows", which is located at the village of Lake Leelanau. The "narrows" is the dividing point between North and South Lake Leelanau.

About 58 percent of the land in the watershed is in agriculture. Of that, approximately 6,200 acres are in orchard crops consisting generally of tart cherries, sweet cherries and apples. There are another 4,400 acres in general farm crops which are mainly corn, small grains and hay. Woodland areas, which include pine, northern hardwood, lowland conifers and other minor forest types, make up about 35 percent of the watershed. There are over 300 houses along the North Lake Leelanau shoreline, with the village of Lake Leelanau on the south end of the lake and the village of Leland at the northwest end of the lake.

Houdek Creek Watershed, a sub-watershed of North Lake Leelanau, is representative of the land use and topography in the North Lake Leelanau Watershed and thus it is assumed that the information gathered for Houdek Creek is valid for the entire North Lake Leelanau Watershed.

According to the Michigan Department of Natural Resources (MDNR), North Lake Leelanau is a high quality lake. Average measured in-lake phosphorus levels range from 5 ug/l in spring to 6 ug/l in summer. The lake has average summer transparency of 11.5 feet and low algae density as measured by chlorophyll a of approximately 2.0 ug/l. North Lake Leelanau has a Trophic State Index (TSI) of 36. A TSI of up to 38 indicates an oligotrophic lake, 39-48 is mesotrophic. Therefore, North Lake Leelanau is very close to degrading to a mesotrophic condition.

The MDNR calculated a phosphorus budget to identify sources of phosphorus loading to the lake. According to this nutrient budget, 36 percent of phosphorus loading comes from the immediate watershed:

Source	Phosphorus	Percent
Immediate Watershed	1134 lbs.	36
Outlet to South Lake Leelanau	1065 lbs.	34
Septic Tanks	72 lbs	2
Precipitation	885 lbs.	28
TOTALS	**3156 lbs.**	**100**

Using quantitative techniques for the assessment of lake quality, in-lake phosphorus concentration is predicted to change by 1 ug/l for every 575-600 pound change in phosphorus loading. According to the Land and Water Management Division of MDNR, a 1 ug/l change in phosphorus would most likely result in a visual and measurable change in the transparency of North Lake Leelanau. In high quality lakes such as North Lake Leelanau, a 1 ug/l change is significant and every effort should be made to reduce phosphorus loading.

With over 303 homes covering the shoreline of North Lake Leelanau and the propensity for owners to want dense, green, well manicured lawns right up to the waters' edge, lawn fertilization is considered to be a major source of phosphorous entering the lake. In the shoreline algae survey of North Lake Leelanau, completed by the Northwest Michigan Regional Planning and Development Commission in 1983, lawn fertilization was considered to be the possible cause of cladophora growth in 32 of the 53 contamination sites identified. In a 1990 Cladophora survey of North Lake Leelanau, completed by Leelanau Conservancy and Leland Township, 121 contamination sites were identified, an increase from the 1983 survey of 111.3 percent. This is coupled with only a 5 percent increase in the number of houses on the lake.

Water Quality Study of North Lake Leelanau (1978), conducted by the Student Water Publications Club at Michigan State University (MSU), was commissioned by the Summer Home Owners of Leland Township and conducted by students under the supervision of Dr. Clifford Humphries (MSU). This study collected water samples from 10 locations in and around North Lake Leelanau on January 21, 1978. Lab tests conducted at MSU included total bacteria, total coliform bacteria, fecal strep, chlorides, orthophosphate, and nitrate.

Results of analysis showed that none of

the water samples had high enough counts of bacteria to cause concern, which might be expected in wintertime sampling. Chemical analysis for orthophosphate indicated elevated nutrient levels at several stations in the extreme north end of the lake, with Houdek Creek singled out as a potentially damaging source of excess nutrients. The report recommended a program to convince lakeshore property owners that fertilizer should not be used on their lawns, and also that a survey of upland land use in the Houdek's Creek area be undertaken as immediately as short-range protective measures.

Lake Leelanau Water Quality Study (1988), was conducted in the fall of 1988 by the Leelanau Conservancy. This study included 8 stations in the North Lake Leelanau Basin. General water quality conditions had apparently changed little since the MSU study of 1978. Houdek Creek remained a problem area, this time with nitrate concentrations at about 10 times the typical background levels for the Lake Leelanau Basin. A considerable effort was made to track down the nutrient loading to Houdek's Creek, and upstream sampling determined that the north branch of the creek is carrying by far the highest nitrate load. Further monitoring of nutrient levels in Houdek's Creek was urged, especially in conjunction with the River Basin Study being conducted by the Soil Conservation Service.

Great Lakes Pollution

Scientists have speculated for years that air pollutants could cause as much as 90 percent of the contamination in some of the five Great Lakes. Lake Superior, which has fewer industries discharging chemicals directly into the water than the other lakes, is believed to get most of its pollution from the air, and estimates for the other lakes indicate that air is a significant source of PCBs, mercury, lead and other toxic compounds.

PCBs, polychlorinated biphenyls, are just one of 11 "critical pollutants" targeted for elimination by the United States and Canada in the 1987 Great Lakes Water Quality Agreement. Manufacture of PCB's, used as insulators and lubricants, has been banned in the United States since the 1970s, but the toxic compound remains prevalent in sediments, landfills and industrial sites throughout the region. Other chemicals considered to cause serious problems in the lakes include mercury, dioxin, lead and DDT, a pesticide that has been banned in the United States but not in Canada or Mexico. Some experts believe some of the DDT still entering Lake Superior may blow into the region from Mexico. According to U.S. Environmental Protection Agency researchers, with the right prevailing meteorology, it could be a five or six-day transport time for air pollutants to get from the Mexico/U.S. border to the Great Lakes.

Lake Michigan has a surface area of 22,300 square miles, which makes it the fourth largest lake in the world and the third largest Great Lake. It drains eastward through the Straits of Mackinac into Lake Huron. Lake Michigan is the second deepest Great Lake, after Lake Superior, with a maximum depth of 923 feet. It contains 1,180 cubic miles of water, which is 22% of the water volume in the Great Lakes. Lake Michigan's flushing time is 69 years. Unfortunately, Lake Michigan continues to serve as a dumping ground for a wide variety of chemical pollutants which make their way into fish and other wildlife and humans farther up the food chain.

MDNR REPORT

The Michigan Department of Natural Resources published a report in April, 1990, entitled ***Water Quality and Pollution Control in Michigan***. The report discusses each of the Great Lakes, including Lake Michigan.

The open waters of Lake Michigan are oligotrophic. Nearshore areas in Green Bay and along the southern portion of the lake are more mesotrophic due to nutrient inputs from industrial activities, urbanization and

agricultural production. The most recent phytoplankton studies on Lake Michigan, made during 1983 and 1984, reflect oligotrophic/mesotrophic conditions.

Lake Michigan total phosphorus levels in water were lower in 1987 (4.9-5.3 ug/1) than in 1983 (5.5-5.7 ug/1) and were significantly lower than 1976 levels (7.8-8.3 ug/1). Nitrates, on the other hand, have increased continually from 224 ug/l (southern basin) in 1976 to 286 ug/l in 1987, increasing at a rate of 7 ug/l/year between 1983 and 1987. Dissolved reactive silica concentrations in open waters have remained stable over the last five years at about 1.06-1.14 mg/l. Chloride concentrations in the southern basin have remained stable since 1983 (mean 8.80 mg/1), but have increased steadily in the northern basin during 1983 to 1987, rising from 8.68 mg/l to 8.83 mg/l. The 1987 sulfate concentrations (20.4-21.4 mg/1) were not significantly different from levels in 1983. Open lake PCB concentrations in 1980 were about 1.2 ng/l.

Of the Great Lakes surveyed under the MDNR fish contaminant survey program, Lake Michigan has been the most heavily impacted, particularly by organochlorine compounds. However, levels of most contaminants in fish are declining. Mercury levels have been declining in the lake since 1972. Data from 1984 showed that contaminants in coho salmon, steelhead, and lake trout less than 20 inches in length, had decreased to the point where 90% or more of the fish tested did not exceed U.S. FDA action levels. However, contaminant levels in lake trout over 25 inches in length, and in carp and brown trout, remained high. Levels of DDT, dieldrin and PCB's were consistently higher in fish taken from the southern end of the lake. These higher levels in fish correspond closely with higher levels of these contaminants in the sediments at the lake's south end.

U.S. Fish and Wildlife Service data from lake trout collected in Lake Michigan indicate that substantial declines in total DDT, chlordane and PCB have occurred. General trends show that dieldrin concentrations in lake trout increased between 1970 and 1979, followed by a decrease between 1979 and 1982. PCB levels in lake trout increased between 1972 and 1974, then declined between 1975 and 1984. DDT concentrations have consistently declined since 1970. Levels of DDT and PCBs in Lake Michigan lake trout are higher than in lake trout from either Lake Huron or Lake Superior.

Acid Rain

Acid rain may also pose a future threat. Acid rain refers to rainwater which is acidic because of air pollutants. It can damage forests and decrease the pH (increased Hydrogen ion concentration) in surface waters to the point that fish cannot survive. Little is presently documented about the extent of damage if any, caused by acid rain in the area. However, data gathered on Beaver Island, 30 miles to the north, shows a nine year average pH of 4.2 and a 1989 (most recent year) average of 5.0. *"Pure"* rain water has a pH value of approximately 5.6, precipitation with a pH below that number is considered to be acidic. The source of acid rain is suspected to be industrial activities, especially those burning high sulfur coal, hundreds of miles away in the Ohio Valley, Chicago, Detroit, and Cleveland areas. Examples of such industries are coal burning electric generating plants and steel making.

National Pollution Discharge Elimination System (NPDES)

There are only four entities presently discharging treated liquid waste via approved NPDES permits. They are listed in Table 4-3.

Table 4-3
NPDES PERMITS

Activity	Location
Frigid Food Products, Inc. (now closed)	Suttons Bay
J L Stowe Oil Co. Bulk Plant	Northport
Leelanau Memorial Hospital	Northport
Suttons Bay Village Hall	Suttons Bay

GROUNDWATER

All residents and visitors of Leelanau Peninsula are dependent upon groundwater resources for their potable water supply. The vast majority of the population reside in single family homes and each household derives its potable water by an on-site private well.

The Health Department has indicated that several residential wells within the Houdek Creek Watershed have nitrate levels testing as high as 16 ppm (the EPA established safe limit for nitrate concentrations is 10 ppm). Other sites with high nitrate levels are scattered throughout the County. With the nitrate contamination that has been documented on Old Mission Peninsula in Grand Traverse County, in similar agricultural enterprises, and with similar soils, the potential for further nitrate contamination of groundwater within Leelanau County is of great concern. Approximately 97 percent of the soils within the watershed have a medium risk of leaching nitrates and other soluble nutrients below the rooting zone.

Several sites in the County have also experienced fuel leaks from underground storage tanks (USTs). These have been primarily at gasoline service stations to-date, but potential for leakage from farm and residential USTs is also of concern. A state-wide inventory of USTs was taken several years ago; however, this inventory excluded tanks smaller than 1,100 gallons. Since many on-farm and residential tanks are in the 500 to 1,000 gallon range, many USTs have gone uninventoried and pose a substantial threat for groundwater contamination.

With many areas of Leelanau County in agricultural use, the use of fertilizer and pesticides is of great concern. Both groundwater and surface water contamination result from extensive use of fertilizers and pesticides in agricultural enterprises. The high nitrate levels observed in groundwater in portions of the County are related to leaching of nitrates on agricultural fields.

Nearly 70 percent of the field crop area and pesticide combinations that are currently being used are rated as having high potential for leaching (high probability that pesticide will leach below the root zone) at least one year out of the rotation.

Known Sites of Contamination

Annually the Michigan Department of Natural Resources publishes a list of known sites of surface soil and groundwater contamination in Michigan. Known as the Act 307 list (from the Michigan Environmental Response Act, PA 307 of 1982 as amended, MCL 691.1201, *et seq*, which requires compiling the registry), it is the leading record of surface and subsurface contamination. As of March 1991, there were 24 sites in Leelanau County on the Act 307 list (see Figure 4-2 and Table 4-1). While this is only 0.0085% of all the sites statewide (2837), one of these sites is on the federal CERCLA (Superfund) list of the top 79 in Michigan (Grand Traverse Overall Supply, a dry cleaning establishment). While many of these sites involve pollution from old industrial activities, gas stations, and facilities using hazardous chemicals, new sites are still being discovered daily in Michigan. Table 4-4 lists Act 307 sites in Leelanau County. Figure 4-2 shows the geographic location of these sites.

Table 4-4
ACT 307 SITES, FISCAL YEAR 1992

Name of Site	Location	Pollutants
Grand Traverse Overall Supply	Solon Twp.	Phthalates, PCE
Vulcan Cincinnati, Inc.	Leelanau Twp.	Chromium, Zinc
Frigid Foods Farms	Suttons Bay Twp.	Lead, Arsenic, Zinc
Total Pet Inc., Marine Terminal	Elmwood Twp.	MTBE
Residential Well	Maple City	BTEX, MTBE
Commercial Wells	Cedar	1,2 DCA; BTEX;1,1 DCA; 1,1,1 TCA
Residential Well	Centerville Twp.	Methyl-t-butyl ether
Holiday Station	Elmwood Twp.	Gasoline, Benzene, Toluene, Xylene, Ethylbenzene
Zephyr, Inc.	Elmwood Twp.	Ethanol, Benzene, Toluene, Xylene
Stowe Oil Co.	Leelanau Twp.	Benzene, Toluene, Ethylbenzene, Xylene
Speedway 2301 (M-22)	Elmwood Twp.	Gasoline
Taghons Service	Empire	Gasoline, Fuel Oil
Elmwood Twp. Dump	Elmwood Twp.	DDT Insecticides
Standard Gas Station	Lake Leelanau	Gasoline
Glens Sanitary LF Inc.	Kasson Twp.	Toluene, 4 Methyl-Phenol, Benzoic Acid, Arsenic
Leelanau County Landfill	Kasson Twp.	Toluene, Phenol, Arsenic, 4 Methyl-Phenol
Sunoco Quik Mart	Bingham Twp.	Gasoline, BTEX
Residential Well	Elmwood Twp.	Fuel Oil
Groundwater Contamination T30N R12W Section 9	Leland Twp.	12 Dichloroethane, Benzene, Toluene, Ethylbenzene, Xylene
Fuel Oil Spill	Leelanau Twp.	Fuel Oil
Peplinski Farm	Centerville Twp.	Benzene, Toluene, Ethylbenzene, Xylene
Konieczka Cottage	Centerville Twp.	Fuel Oil
Leelanau County Road Commission	Maple City	Salt
Leelanau County Road Commission	Suttons Bay	Salt

Groundwater Vulnerability

Approximately 60% of the mainland portion of the County is on "sensitive" aquifers. These are aquifers located below soils with high permeability. Approximately 40% of thie County lies over "protected" aquifers, which are located below layers of soil (clay) or rock which are not very permeable (See Figure 4-3). However, because the soil is saturated below the surface, all groundwater is linked

and contaminants can flow around "protected" layers. The only variables are time and volume of flow.

The highly permeable sandy soils in Leelanau County present a ready conduit for groundwater contamination, and it is unlikely that all existing sites of contamination have as yet been discovered. The highly vulnerable soils of the Peninsula require the use of careful measures when establishing new facilities using hazardous chemicals. Similarly, other potential pollutant sources, such as septic systems, need to be carefully sited and regularly serviced and inspected.

Existing contamination sites should be quickly cleaned up to prevent the spread of pollutants over a wider area and to prevent the eventual contamination of surface water. Contamination of groundwater from septic systems is ideally stopped or prevented by installing public sewers. Unfortunately, low density sprawl and linear development patterns characteristic of the County make the costs of doing so prohibitive.

EMERGING ISSUES

Surface waters are vulnerable to contamination due to the lack of a coordinated stormwater management program. The future quality of Leelanau County's water resources will also be impacted by pollutants discharged directly to surface waters. Concerns for and threats to these water resources will heighten as future residential development escalates the use of lawn fertilizers, pesticides, and household chemicals. These pollutants and others from agricultural operations could damage ecosystems, as well as the continued marketability of Leelanau County as a tourist destination. Pressure upon lake and stream shoreline areas for future development will compromise area water quality unless very carefully designed and sited in accordance with coordinated stormwater management regulations. Water quality monitoring, if uniform and cost-sustainable, could serve as a basis for adopting new regulations.

Wetland Development

Many of the undeveloped sites along lakes in the Peninsula are undeveloped due to the fact that they are wetland sites. With quality lake lots becoming more difficult to find, a great deal of pressure is being put on these wetland sites. An awareness of the potential for surface and groundwater degradation from wetland development has surfaced over the past few years and is a definite concern of many citizens in the County. Increased development of wetland along lakes and streams in the Peninsula will only increase the severity of degradation of the waters within the watershed. New measures may be needed to assure that this large percentage of the watershed is protected from development that would cause degradation of both ground and surface waters.

Shoreline Development

The shores of inland lakes have long been popular places for residential development because of the attractive and unique natural setting they offer. Because these areas are relatively fragile components of the natural environment, they are easily degraded by activities associated with development. Many lakes become severely degraded in small increments and over long periods of time; in some cases 30 to 50 years. Some of the most common problems associated with lakefront residential development which affect lake water quality are increased soil erosion and sedimentation, lack of effective sewage treatment (mostly due to inadequate or failing septic tanks), and runoff from lawn fertilizers and household cleaning products.

All of these problems can be detected early and corrected to protect the quality of lakes. The most obvious preventative measure is to restrict development on lakes. For lakes that are already intensely developed, measures are needed to ensure that septic systems are working properly, homeowners are educated about the effects of lawn fertilizers and household products on lakes, and

erosion and runoff are controlled.

ISSUES FOR FURTHER DISCUSSION

What measures are necessary to maintain the existing high quality of the Peninsula's inland lakes and streams? How much of a role should local governments or the County play in improvement of existing conditions and prevention of future problems? To what extent can geographic information systems (GIS) be used in monitoring and evaluating land use impacts on the environment? What data sets are needed to use GIS technology in Leelanau County?

1. *New air monitoring network tracks contaminants in lakes,* **Kalamazoo Gazette.** April 26, 1992.
2. **Water Quality and Pollution Control in Michigan,** Michigan Department of Natural Resources, Surface Water Quality Division. April, 1988.
3. **Staff Report: A Biological Survey of the South Lake Leelanau Tributaries of Mebert Creek, Cedar Run Creek, and Victoria Creek,** Michigan Department of Natural Resources, Surface Water Quality Division. August, 1990.
4. **Staff Report: A Biological Survey of the Crystal River,** Michigan Department of Natural Resources, Surface Water Quality Division. July, 1987.
5. **Staff Report: Biological Survey of an Unnamed Tributary to West Bay, in the Vicinity of Greilickville, Leelanau County, Michigan,** Michigan Department of Natural Resources, Surface Water Quality Division. May, 1989.
6. **Staff Report: A Biological Survey of Ennis and Belanger Creeks,** Michigan Department of Natural Resources, Surface Water Quality Division. August, 1988.
7. **Resource Plan: Houdek Creek Watershed,** Leelanau County Local Coordinating Committee. February, 1991.

Chapter 5
SUMMARY

OVERVIEW

Leelanau County has much to offer in terms of its attractive natural environment and abundance of forest and farmlands. The County produces a large quantity of tree fruits, has become a hub for tourism in Michigan, and continues to have relatively high quality lakes and streams. Many of the Peninsula's natural resources are unspoiled, and this presents citizens with unique opportunities. The County is in this unique position because many areas of Michigan have seen their natural resources (especially inland lakes and streams) degraded and polluted, both visually and chemically. Once diminished or lost, many natural resources and environmental features cannot be reclaimed.

Unfortunately, the same land use activities that take advantage of unique natural resource opportunities on the Peninsula – agriculture, tourism, and residential development – threaten to create irreversible problems and degrade the lands they depend upon. Some key land use problems have been identified and documented in this working paper. In addition to potential land degradation, high quality inland lakes are threatened by agricultural runoff and sedimentation, and by old and malfunctioning sewage disposal systems along their shores. Groundwater is threatened by chemicals and sewage leaching into the highly permeable soils from agricultural activities and septic systems.

These are problems that will not go away and cannot be ignored if the natural environment of the Peninsula is to continue to present opportunities for profit and enjoyment.

FUTURE DEVELOPMENT ON THE PENINSULA

Protection of Natural Resources

Protection of the Peninsula's natural resources ultimately depends on the willingness of local governments and citizens to get involved in regulating and correcting land use problems. This can be achieved through comprehensive land use planning and through regulations tailored specifically to the unique situation of each community.

Even though some environmentally sensitive areas (wetlands, high risk erosion areas, critical sand dunes) in the County are subject to state regulation, there are still numerous sensitive environments of local importance which are not protected by state or federal laws. Some of these include inland lakeshore areas, small wetlands, many valuable resource lands such as unique farmlands or unique forestlands, and scenic vistas. For example, state laws do not regulate the density of development on inland lakes - only local governments can limit lot sizes or use other planning and zoning tools to preserve their locally important resources.

Unchecked development occurring in small increments over time is probably the most preventable cause of environmental destruction. Unfortunately, most local governments will not address the situation until a problem presents itself. Then, it is usually too late to solve or prevent most environmental problems. Leelanau County is unique in that many of its natural resources are still intact. However, the Peninsula is also very vulnerable to environmental neglect because it is one of a few areas in Michigan in such a condition. New development and tourists will thus flock to Leelanau County in increasing numbers, placing bigger demands in its resources.

Protection of Community Character

Maintaining community character is almost completely dependent on the actions of local governments and citizens. Unlike some natural resources of value to the state as a

whole, state government has relatively little interest in preserving the aesthetic, rural, or social character of most communities. State regulations do not prohibit development from encroaching on elements of a community's character. However, statutes do provide local governments with the planning and regulatory authority necessary to preserve that character.

Much of the character of communities within Leelanau County is derived from their natural setting. Thus, local protection of the natural environment represents a significant step in preserving rural character.

KEY ISSUES FOR FURTHER DISCUSSION

- Endangerment of valuable resource lands
- Local government role in protecting natural resources
- Development in environmentally sensitive areas
- Local government role in protecting environmentally sensitive areas
- Development on inland lakes
- Protection of groundwater supplies
- Provision of technical expertise and base of information on the natural environment – for policy development and local government administration.

RECOMMENDATIONS

- Education of local officials and citizens on land use planning and environmental protection
- Local government involvement in protecting community character
- Local government involvement in protecting natural resources
- Continued development of Leelanau County's geographic information system.

Appendix A

REPORTS AND DOCUMENTS REVIEWED

1991 ACP Water Quality Special Project Request: North Lake Leelanau Watershed, United States Department of Agriculture, MSU Cooperative Extension Service, Leelanau Soil Conservation District, Michigan Department of Natural Resources, Leelanau Conservancy, Northwest Michigan Council of Governments, and Northwest Michigan Resource Conservation and Development Council. June, 1990.

Environmental Health Regulations for Leelanau County Health Department, Chapter 2; Sewage Disposal.

First Annual Report of the Leelanau Conservancy Watershed Council Water Quality Monitoring Program, Tim Keilty, Ph.D. February, 1991.

Goemaere-Anderson Wetland Protection Act, PA 203 of 1979, MCL 281.701 *et seq.*

Great Lakes Water Levels, Michigan Department of Natural Resources, Division of Land Resource Programs. Date unknown.

Great Lakes Water Wreaks Shore Havoc, **Natural Resources Register**, Michigan Department of Natural Resources. March, 1986.

Important Farmlands Map of Leelanau County, Michigan, USDA Soil Conservation Service. 1978.

Leelanau County Forest Soils Report, Northwest Michigan Prime Forestlands Identification Project. 1982.

Leelanau County Solid Waste Plan, Leelanau County Planning Department and Leelanau County Board of Commissioners. 1989.

Michigan Hydric Soils List, USDA Soil Conservation Service.

Michigan's 1988 Nonpoint Pollution Assessment Report, Michigan Department of Natural Resources, Surface Water Quality Division. November, 1988.

Michigan Shorelands Protection and Management Act, PA 203 of 1979, MCL 281.701 *et seq.*

Michigan Sites of Environmental Contamination Act 307, Michigan Department of Natural Resources, Environmental Response Division. March, 1991.

New air monitoring network tracks contaminants in lakes, **Kalamazoo Gazette**. April 26, 1992.

Resource Plan: Houdek Creek Watershed, Leelanau County Local Coordinating Committee. February, 1991.

Sand Dune Protection and Management Act, PA 222 of 1976 as amended, MCL 281.651 *et seq.*

Staff Report: A Biological Survey of Ennis and Belanger Creeks, Michigan Department of Natural Resources, Surface Water Quality Division. August, 1988.

Staff Report: A Biological Survey of the Crystal River, Michigan Department of Natural Resources, Surface Water Quality Division. July, 1987.

Staff Report: A Biological Survey of the South Lake Leelanau Tributaries of Mebert Creek, Cedar Run Creek, and Victoria Creek, Michigan Department of Natural Resources, Surface Water Quality Division. August, 1990.

Staff Report: Biological Survey of an Unnamed Tributary to West Bay, in the Vicinity of Greilickville, Leelanau County, Michigan, Michigan Department of Natural Resources, Surface Water Quality Division. May, 1989.

STORET data on North Lake Leelanau, South Lake Leelanau, Little Glan Lake, Glen Lake, Little Traverse Lake, Lime Lake, Cedar Lake, and School Lake, Michigan Department of Natural Resources, Surface Water Quality Division.

USDA Soil Survey of Leelanau County, Michigan. United States Department of Agriculture, Soil Conservation Service, 1973.

Vegetation and its Role in Reducing Great Lakes Shoreline Erosion: A Guide for Property Owners, Michigan Sea Grant College Program. 1988.

Water Quality and Pollution Control in Michigan: 1988 Report, Michigan Department of Natural Resources, Surface Water Quality Division. April, 1988.

Water Quality and Pollution Control in Michigan: 1990 Report, Michigan Department of Natural Resources, Surface Water Quality Division. April, 1990.